AN ENGINEERING STUDY OF AN EXTENSION OF path VIA NEWARK AIRPORT TO ELIZABETH AND WEST ON THE CENTRAL RAILROAD OF NEW JERSEY

PREPARED FOR
THE STATE OF NEW JERSEY
DEPARTMENT OF TRANSPORTATION
AND
THE PORT OF NEW YORK AUTHORITY

by

LOUIS T. KLAUDER AND ASSOCIATES
Consulting Engineers

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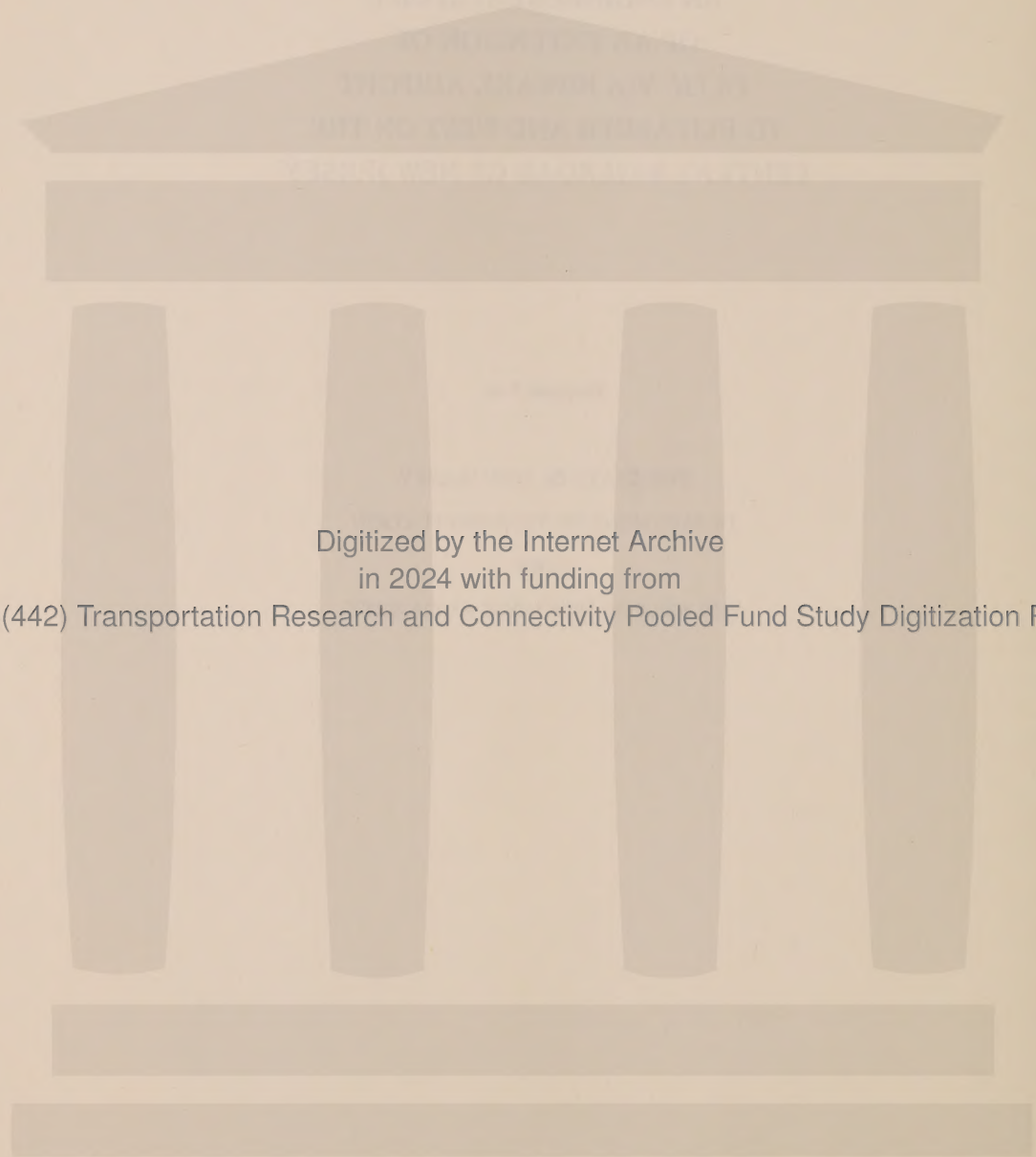

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December 31, 1971
File No. 1068–76

The State of New Jersey
Department of Transportation
1035 Parkway Avenue
Trenton, New Jersey 08625

The Port of New York Authority
111 Eighth Avenue
New York, New York 10011

Subject: An Engineering Study of an Extension of PATH via Newark Airport to Elizabeth and West on the Central Railroad of New Jersey

Gentlemen:

We are pleased to submit herewith the report of our study of a PATH extension to Newark Airport, Elizabeth and Cranford.

This report proposes a level of service and fare structure, provides the forecast of riding, the route and facilities required, and provides our estimate of the cost of construction of the extension.

We are grateful to staff members of the Port Authority and PATH for providing statistical and engineering data as well as general advice during the study.

We also wish to thank the New Jersey Department of Transportation for supplying data on the various area transportation systems, and contributing estimates of the cost of real estate necessary for right-of-way.

The forecasts of traffic to which reference is made in this report were prepared by Wilbur Smith and Associates. The detailed design and estimate of costs of roadway structures were prepared by Ammann & Whitney. We wish to acknowledge their important part in the study.

We appreciate the opportunity to take part in this investigation.

Yours very truly,

LOUIS T. KLAUDER AND ASSOCIATES

Louis T. Klauder

Louis T. Klauder

LTK/bld
Enclosure

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

LIST OF PLATES

LIST OF PLATES (Cont'd)

LIST OF TABLES

LIST OF TABLES (Cont'd)

SECTION I

INTRODUCTION

The objectives of this study are to investigate and analyze the route and station locations, permanent facilities and operations for a proposed extension of the existing PATH rail line from Newark to Newark Airport and from there to Elizabeth and Cranford, New Jersey. This extension will provide a safe and reliable rail connection between Manhattan and one of the three major airports in the New York metropolitan area.

The study has focused on the selection of a route for the extension, estimation of construction costs of the permanent way, stations, signals, traction power and storage yards, estimated cost of additional vehicles and the preparation of a feasible operating schedule. The potential ridership attracted to the system because of the extension has also been estimated.

Important considerations in the design of this facility are to provide rapid transit access to the new and growing industrial complex lying east of Elizabeth, along Dowd Avenue, and to accomplish the extension with minimal disruption of environment or destruction of homes and tax ratable commercial and industrial property.

In accordance with the terms of our contract revenues generated by the increased traffic have not been calculated nor has any financial analysis been undertaken to determine the marginal cost of operations on the extension.

For the same reason we did not investigate operations on the existing PATH system with regard to improvements in travel time, operation stability, or increased efficiency through possible improvements to the signal and control systems.

Our estimates of the cost of construction and equipment do not include the cost of respacing the signals and increasing substation capacity between Journal Square and Newark to provide for 90-second headways although this capability is assumed in the suggested operating schedules. We have not estimated the cost of modifying the propulsion equipment on the existing PATH car fleet to operate at the original maximum design capability although this improvement would be expected. We have not included the cost of equipping these cars for the automatic speed control signal system recommended for the extension.

The route for the PATH extension has been selected to provide station locations at South Street (in Newark), Newark Airport, North Avenue (Elizabeth), Central Elizabeth, Elmora Avenue (Elizabeth), Roselle, Garden State Parkway crossing, and Cranford. Tracks between Newark Station and the Newark Airport will be carried on elevated structure except for a short section using right-of-way of the Penn Central Railroad Tracks will be carried on elevated structure between Newark Airport and the Elizabeth freight yard of the Central Railroad of New Jersey. From this yard to Cranford the tracks will be located on right-of-way of that railroad.

The extension will use existing cars of the most recent type now operating in the PATH fleet supplemented by purchase of additional cars of similar size and capability. These cars will permit speeds up to 70 mph and provide peak-hour trip times from the World Trade Center as follows:

To Newark Airport	27 minutes
To Elizabeth	32 minutes
To Garden State Parkway	40 minutes
To Cranford	42 minutes

Off-peak operations will reduce these times by one minute.

We suggest peak hour schedules providing ten trains per hour to the Airport and five trains per hour to Cranford. Corresponding off-peak schedules provide six trains per hour to the Airport and three trains per hour to Cranford.

The estimated total cost at current prices is $174 million. Construction of roadway and terminal facilities accounts for $121 million, stations and parking for $15 million, property acquisition for $18 million, and new cars for $20 million. This total cost, if escalated through a seven year construction period would be $256 million.

Preparation of designs, acquisition of necessary property, construction of the entire line, and delivery of major equipment is estimated to require four to seven years after approval of project. Completion of the segment to Newark Airport could be completed within four to five years.

SECTION II

DESCRIPTION OF THE AREA TO BE SERVED BY THE EXTENSION

The proposed extension would lie in the Tidewater area of northeastern New Jersey and provide extended service to the industrial complexes of Elizabeth and to the residential suburbs of the Roselle and Cranford areas. Dense development has occurred in the Elizabeth area since the founding of this, the oldest English settlement in New Jersey, and today the growth opportunities lie in the intensification of development on land which has already been through a first stage of use. The Newark-Elizabeth area is the largest industrial and manufacturing complex in the entire State, specializing in machinery, chemicals, food processing and textiles.

The last decade has seen a decline in the economic vitality of the centers of both Newark and Elizabeth. There is great desire to stimulate redevelopment through the attraction of new employment opportunities and a revitalization of the regional economy. PATH's contribution to this increased development would be the improvement of accessibility to a growing industrial complex lying south of the Airport along Dowd Avenue. There is also hope that the redevelopment taking place in the center of Newark could act as a new destination point for commuters from the western suburbs. It should be noted that the incorporation of a station at South Street, Newark, increases the accessibility to a small commerical and industrial area which is now suffering from deterioration and decline.

The proposed transit line would lie primarily along already well developed transportation corridors south from Newark to Elizabeth and then west from Elizabeth to Cranford along the right-of-way of the Central Railroad of New Jersey. After leaving the Airport on the way to Elizabeth, the line would pass through the newly developing Dowd Avenue light industrial park area.

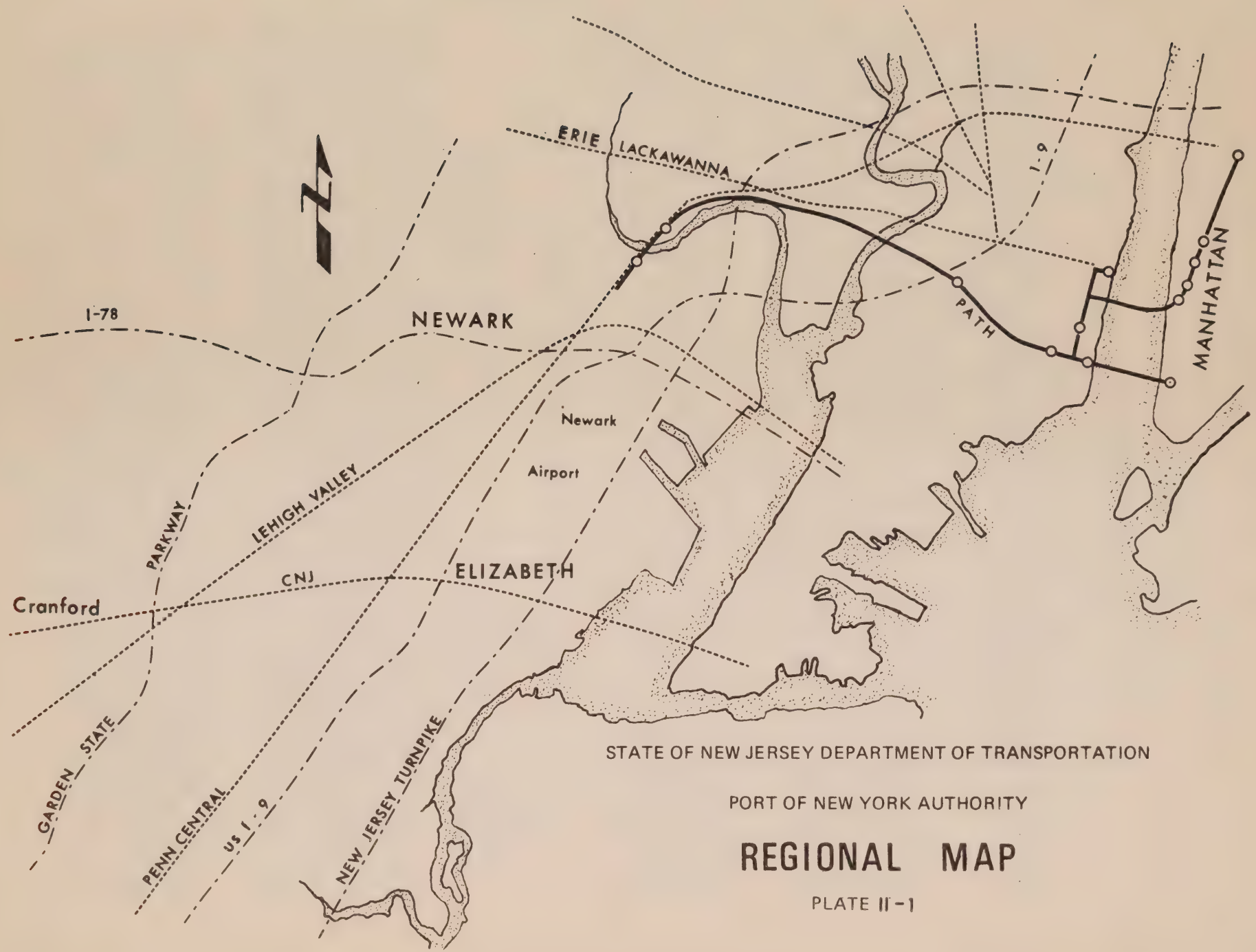
The western extension of the line from the Airport to Cranford will serve Elizabeth, Roselle and Cranford, all lying in Union County. This area is relatively highly developed with moderate income suburban communities forming part of the New York City commuter shed. Only minimal population and employment growth has been projected for the corridor of the proposed extension as the following table indicates.

TABLE II–1
Population & Employment in the Service Area

	Population (000)		Employment (000)		Median Income
	1970	1985	1968	1985	(1959)
Newark	382	375	288	300	$5,454
Elizabeth	113	116	64	74	6,429
Roselle Area*	46	50	14	20	7,273–7,764
Cranford Area**	115	125	22	33	8,863–10,549

* Includes Roselle Park and Kenilworth
** Includes Garwood and Westfield

For comparison the 1959 Median income for New Jersey was $6786, Union County was $7746.



STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION

PORT OF NEW YORK AUTHORITY

REGIONAL MAP

PLATE II-1

SECTION III

NEWARK AIRPORT

Newark Airport is characterized as a domestic airport primarily serving the Manhattan business community and the New Jersey suburbs with approximately 7,000 average daily air passengers. Presently Newark's share of the Manhattan domestic Air Passenger market is about 15% of 13–14,000 total daily passengers.

An extensive analysis of the origins and destinations of airport users has been performed by the Port Authority which has determined that, although the final origins and destinations of users are widely dispersed throughout the Metropolitan Region, a significant percentage (28%) of Newark's air passengers are destined to the island of Manhattan. The provision of a PATH connection to Lower Manhattan may result not only in attraction of a greater percentage of the Lower Manhattan market to Newark Airport but may actually increase the proportion of air trips which have origins and destinations in that location because of the increased accessibility.

The Port Authority has provided projections for 1980 and 1985 based on estimates for the total New York air passenger market. The total traffic at Newark will, of course, be influenced by the trend in total air passenger usage, the existence of STOL Ports in the New York region and the distribution of scheduled flights among the three New York City airports. Projected air passenger traffic at Newark under the influences mentioned above, as estimated by the Port Authority, are listed in the following table.

Table III-1 Estimated Annual Newark Air Passengers

	1980	1985
Without STOL Port in Meadows	11,810,000	16,650,500
With STOL Port	9,910,000	14,100,500

The Port Authority has progressed almost to completion with a modernization program of some $200 million for completely new terminal facilities and runway construction expected to triple Newark Airport's passenger capacity. In conjunction with this program access roads and parking facilities will be greatly expanded to increase Newarks attractiveness and accessibility. An interterminal transit system (ITT) will link the three terminal buildings and connect them with the remote parking lot and PATH Station. The impact of these improvements on Newark Airport's share of the Metropolitan air passenger market have not been analyzed, but an increase from the present 23% may be expected.

The land available for expansion at Newark Airport has been severely limited by the intensive development on all sides of the airport property and the existence of major transportation corridors along all perimeters. The modernization program has utilized almost all of the available land. Factors governing the locations available for a PATH station include consideration of flight path clearances, the possible location of a STOL runway on the Newark Airport property the necessity for a transfer between PATH and the ITT and a desired allowance for possible future expansion of Terminal A (see Plate III–1).

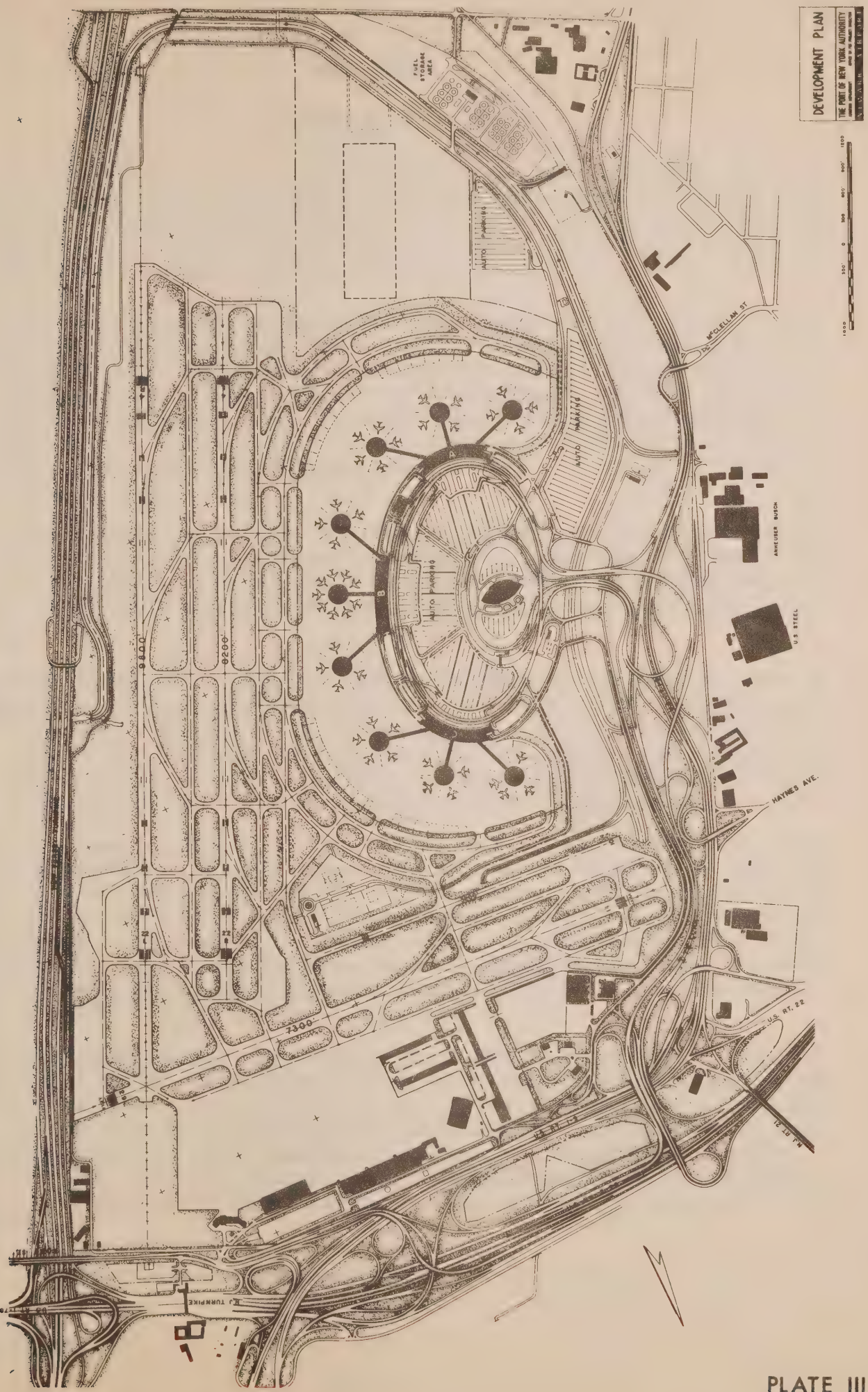

DEVELOPMENT PLAN
THE PORT OF NEW YORK AUTHORITY
FUEL STORAGE AREA
AUTO PARKING
McCLELLAN ST
ANHEUSER BUSCH
U.S. STEEL
HAYNES AVE.
U.S. RT. 22
N.J. TURNPIKE
9800'
9200'
7300'

PLATE III-1 6

SECTION IV

EXISTING TRAVEL PATTERNS

The study corridor is within the most densely developed region in the United States, Manhattan being the focal point of much of the interstate travel. These trips are served by a number of major highways and rail facilities in New Jersey and New York. About half of the daily trans-Hudson travel requirements are served by public transportation due to limited highway capacity and comparatively lower cost involved in travel via public transportation.

Prior surveys, conducted in 1963 by the Tri-State Transportation Commision, now the Tri-State Regional Planning Commission, and in 1968 by the Port of New York Authority, have quantified the magnitude of travel by mode for trans-Hudson River crossings and for intra-New Jersey travel in this important area. In 1963, there were almost 900,000 total passengers crossing the Hudson River daily into Manhattan, Connecticut and Westchester County, as compared with more than 1.0 million passengers in 1970. Facilities serving these movements are the Penn Central Railroad, PATH, the Tappan Zee Bridge, the George Washington Bridge, the Lincoln and Holland Tunnels, and the Verrazano Narrows Bridge.

Along the study corridor served by the PATH extension, approximately 40,000 one-way person-trips are made between New York and New Jersey daily. About 8,000 of these are on the existing PATH system. The areas affected by the extension of the PATH system are shown in shaded portions of Plate IV–1. These include most of Union County, Elizabeth, Roselle Park, Cranford, Westfield and other communities.

Along trips between New York and the study corridor, approximately 16 per cent of the people are now traveling by automobile during peak periods, as compared with 67 per cent in off-peak periods, given in Table IV–1. During peak periods, almost 60 per cent of the total use rail as a prime travel mode, contrasted with about 24 per cent using buses. During off-peak periods, about 19 per cent of the travelers use buses and 14 per cent use rail. These are travelers from all of Union County, with the exception of movements from Summit, New Providence, Berkely Heights, Plainfield, and Rahway.

An additional segment of potential travel for extended PATH are comprised of intra-New Jersey trips. From 1963 Tri-State data, it is apparent there were some 60,000 person trips within this corridor which could potentially be served by the PATH extension. Approximately 75 per cent of the total use automobiles as their primary travel mode, as given in Table IV–2. This compares with approximately 19 per cent using bus and about 6 per cent using rail facilities. The market area for this segment of travel potential for the PATH extension encompasses the municipalities of Newark, Harrison and Jersey City and all of Union County excepting Summit, New Providence, Berkeley Heights, Plainfield, Rahway, Scotch Plains, and Fanwood.

The additional market for this extension comprises air travelers, visitors, and employees oriented to Newark Airport. In 1967, there were approximately 13,000 daily air passengers frequenting this generator. Conventionally, this represents about one third of the total persons at an airport on a typical weekday. From domestic in-flight surveys prepared by the Port of new York Authority, approximately 59 per cent of the departing air passengers arrive at the airport by automobile, 12 per cent by taxis, 13 per cent by airport buses, and approximately 4 per cent by suburban limousine service, as given in Table IV–3. Buses serve about 9 per cent of the daily total travel to Newark Airport.

(This section contributed by Wilbur Smith and Associates)

ANALYSIS ZONES

STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION
PORT OF NEW YORK AUTHORITY
EXTENSION OF PATH VIA NEWARK AIRPORT
TO ELIZABETH & CRANFORD

LOUIS T. KLAUDER AND ASSOCIATES

PLATE NO. IV-1

Wilbur Smith and Associates

Table IV-1

TRANS-HUDSON PERSON TRIPS BY MODE
Potential Market Area (1)

1968

MODE	AVERAGE WEEKDAY PERSON TRIPS Number	Per Cent
Peak Period (2)		
Auto	3,225	16.0
Bus	4,910	24.3
Rail Modes		
PATH	6,725	33.4
Other Rail	5,300	26.3
Subtotal	12,025	59.7
TOTAL	20,160	100.0
Non-peak Period		
Auto	13,195	67.0
Bus	3,740	19.0
Rail Modes		
PATH	1,230	6.2
Other Rail	1,535	7.8
Subtotal	2,765	14.0
TOTAL	19,700	100.0
GRAND TOTAL	39,860	

Total PATH Extension Trips:

Average Weekday	7,955
Average Annual	2,140,000

(1) Potential market area includes all of Union County except Summit, New Providence, Berkeley Heights, Plainfield and Rahway.
(2) Includes trips made during 6:00 to 10:00 A.M. and 4:00 to 7:00 P.M.

SOURCE: Port of New York Authority, 1968 Trans-Hudson Origin and Destination Surveys.

Table IV-2

INTRA-NEW JERSEY PERSON TRIPS BY MODE
Potential Market Area(1)

1963

MODE	AVERAGE WEEKDAY PERSON TRIPS Number	Per Cent
Work Trips		
Auto	25,390	75.5
Bus	6,295	18.8
Rail Modes	1,730	5.7
PATH	N.A.	-
TOTAL	33,415	100.0
Non-Work Trips		
Auto	19,670	75.3
Bus	5,235	19.8
Rail Modes	1,270	4.9
PATH	N.A.	-
TOTAL	26,175	100.0
GRAND TOTAL	59,590	

(1) Includes all of Newark, Harrison, Jersey City and Union County, excepting Summit, New Providence, Berkeley Heights, Plainfield, Rahway, Scotch Plains, and Fanwood.

SOURCE: Tri-State Transportation Commission, 1963 Home Interview Survey.

Table IV-3

ORIGIN OF PASSENGERS DEPARTING BY AIR FROM NEWARK AIRPORT
BY MODE OF GROUND TRANSPORTATION TO AIRPORT (1)

1967

ORIGIN	DEPARTING DAILY PASSENGERS	MODE OF GROUND TRANSPORTATION					
		Auto	Taxi	Airport Coach	Limou-sine	Public Bus	Other
		(Per Cent of passengers)					
East of Hudson							
Manhattan	1,819	20	17	41	3	16	3
Brooklyn (2)	88	-	-	-	-	-	-
Other (2)	296	-	-	-	-	-	-
Subtotal	2,203	26	15	37	4	15	3
West of Hudson							
Union	667	79	11	-	7	3	-
Essex	701	72	19	1	3	5	-
Hudson	216	75	21	-	1	3	-
Richmond (2)	101	-	-	-	-	-	-
Bergen	627	84	6	-	8	2	-
Passaic (2)	209	-	-	-	-	-	-
Morris	418	75	8	2	10	1	4
Somerset (2)	135	-	-	-	-	-	-
Middlesex	357	86	8	-	2	4	-
Monmouth	337	73	7	-	3	12	5
Orange-Rockland (2)	87	-	-	-	-	-	-
Subtotal	3,855	79	11	-	5	4	1
Outside Metropolitan Area	681	59	9	4	2	18	8
TOTAL	6,739	59	12	13	4	9	3

(1) Excludes transfer passengers.
(2) Based on too few cases to merit estimation.

SOURCE: Port of New York Authority, Aviation Economics Division.

SECTION V

THE EXISTING PASSENGER TRANSPORTATION SYSTEM

COMMUTER RAILROADS

Commuter railroad service is presently provided to Elizabeth, North Elizabeth and South Street, Newark by the Penn Central Railroad. The Central Railroad of New Jersey provides commuter rail service to Roselle Park and Cranford, New Jersey. Both of these services are peak hour commuter services with long headways between trains during off peak hours.

Elizabeth is by far the best served station as trains of several services from Trenton, New Brunswick and the New Jersey Shore communities stop there. During the morning and afternoon peak hours there is a choice of five trains per hour to Midtown Manhattan and during off peak hours there are two or three trains per hour. North Avenue and South Street in Newark have virtually no service (South Street has five inbound and three outbound trains per day) particularly during the off peak. Passengers destined for downtown Manhattan must transfer to PATH at Newark. The eastbound transfer is made across the platform but the westbound transfer is awkward and time consuming as it involves a change in platform levels at Newark station.

The Central of New Jersey mainline rail service terminates at Newark where the 5,000 daily Manhattan commuters must transfer either to Penn Central or to PATH depending on destination (uptown or downtown Manhattan). Cranford and Roselle Park have a peak hour frequency of three trains and an irregular one train per hour service during the rest of the day.

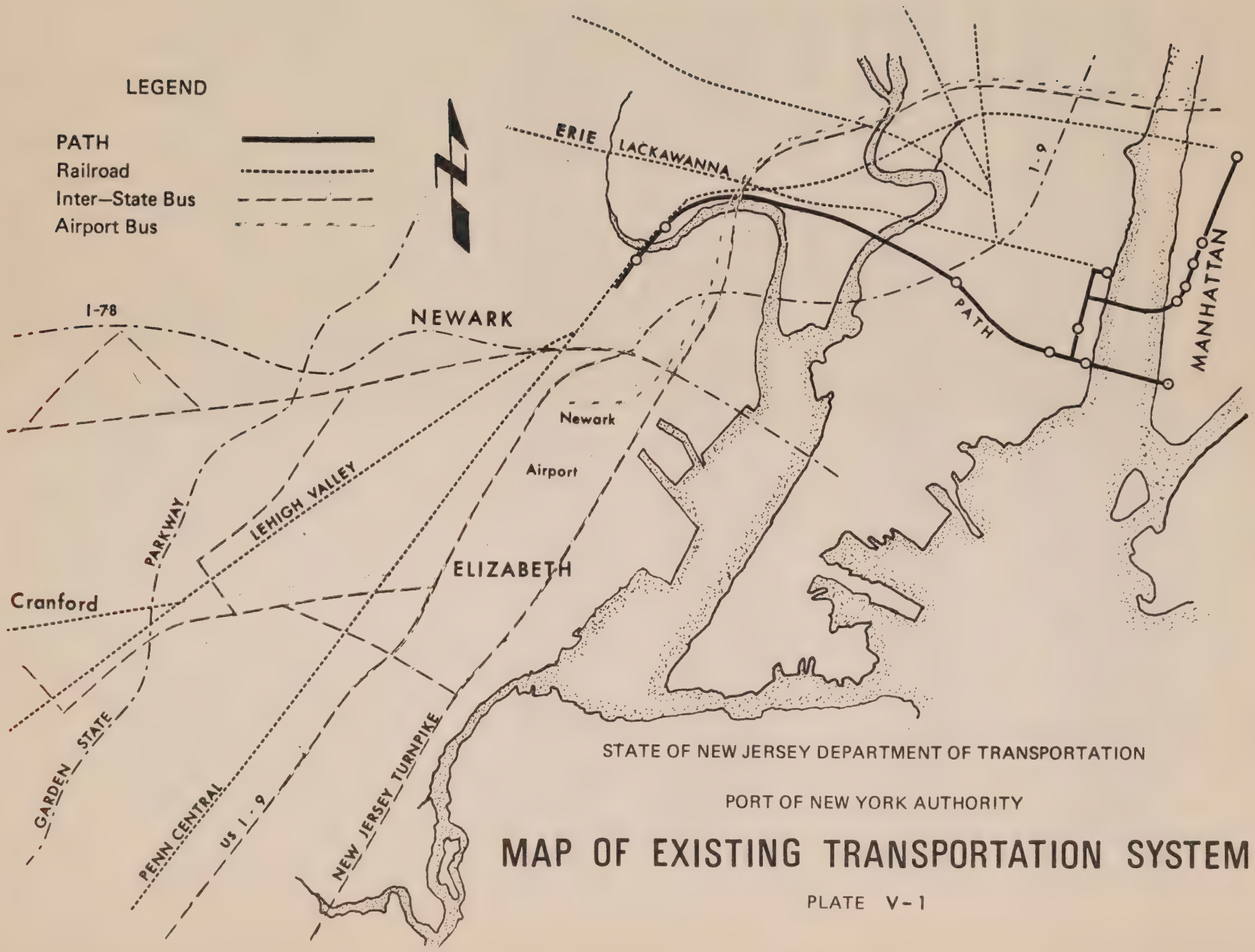
In all cases the Penn Central and Jersey Central services operate on irregular headways as is typical of commuter railroads. Travel times, including transfers for destinations in lower Manhattan are shown in the following table:

TABLE V–1

Rail Travel Times (including Transfer to PATH) in Minutes

	Destinations		
Origins	Penn Station VIA PCRR	33rd Street VIA PATH	World Trade Center VIA PATH
Elizabeth	25	41–48	31–35
Newark	15–16	28–29	18–19
Roselle Park	35	47–51	37–41
Cranford	41	53–57	43–47

The comparative travel times to 33rd Street via PATH, which includes transfers at Newark and Journal Square, indicate the uncompetitive nature of this service.



STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION

PORT OF NEW YORK AUTHORITY

MAP OF EXISTING TRANSPORTATION SYSTEM

PLATE V-1

BUS LINES

Local bus service is furnished by Transport of New Jersey, formerly Public Service Coordinated Transport, in the area to be serviced by the proposed PATH extension. TNJ also operates interstate commuter buses to the Port Authority Bus Terminal in competition with several other private bus lines. The recent improvement to the approaches to the Lincoln Tunnel through the provision of a separate peak hour bus lane has reduced the overall travel time by this mode anywhere from ten to twenty-five minutes and resulted in a more stable operation.

HIGHWAY

Automobile transportation is the predominant mode of use for intrastate trips in the northern New Jersey region and also for airport access. Because of traffic congestion on the Trans Hudson bridges and tunnels and the high parking rates in Manhattan it is not the primary mode of interstate travel during peak hours.

NEWARK AIRPORT ACCESS

The principal access to the Newark Airport is by automobile for total daily passengers because of the dispersed origins and destinations of all trips. The largest single origin or destination for airport users is midtown Manhattan which is best served currently by the Carey Bus Company. The airport is also accessible by taxi and by TNJ bus. The former is prohibitively expensive ($15.00 to $20.00) for most airport passengers while the latter does not stop at the airport terminal buildings but does have a very low fare, sixty-five cents.

The major proposed changes to transportation access to Newark Airport revolve around plans for improved highway interchanges (Interstate 78 and New Jersey Route 81) which are either in the design or construction stage. These changes will benefit primarily air passengers from the New Jersey communities and will have relatively little impact on air passengers from New York City who must cross the Hudson River.

SECTION VI

EXISTING PATH SYSTEM

The Port Authority Trans-Hudson service began in 1962 when the Port of New York Authority assumed operations of the Hudson and Manhattan Railroad Company. The current system functions primarily as a Trans-Hudson commuter service for passengers on Erie-Lackawanna trains in northern New Jersey suburban communities, on Central of New Jersey and Penn Central trains in the Newark, Essex County and Shore communities, and for bus passengers arriving at the Journal Square Station in Jersey City. With a fleet of 298 cars (including 46 cars on order), of which 205 are the PA1 and PA2 design purchased since 1962, the system provides connections between Hoboken and Newark in New Jersey with the World Trade Center and 33rd Street on the island of Manhattan. A diagram of the system is shown in Plate VI–1.

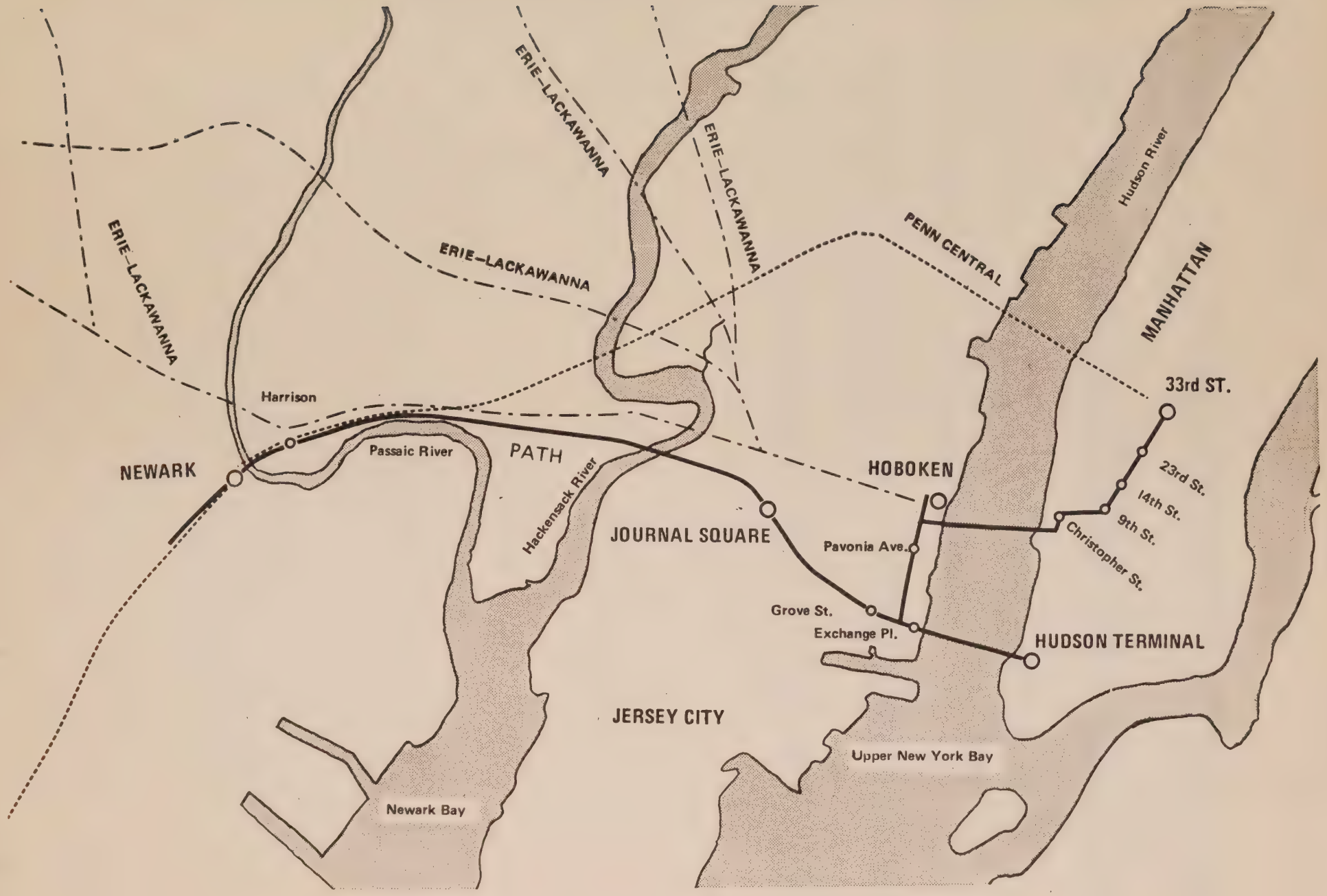
Four separate services are run on the PATH system: Newark to World Trade Center; Journal Square to 33rd Street; Hoboken to the World Trade Center; Hoboken to 33rd Street. We anticipate that the latter two services (from Hoboken) will not be affected significantly by the proposed extension from Newark to the Airport and Cranford.

Trains on the Newark to World Trade Center line are scheduled to provide 3 to 6 minute headways during the peak periods and 10 minute headways during the off-peak hours. Trains from Hoboken to 33rd Street are scheduled to provide 6 minute headways during the peak hours while trains from the World Trade Center are on three minute headways. Ten minute headways are used during off-peak.

An extensive survey performed by the Port Authority in 1968 indicated that most of the passengers on PATH arrived at Newark or Hoboken by commuter train and at Journal Square by bus. Total ridership has increased since 1962 from 104,000 passengers per day up to about 145,000 passengers per day. Of particular importance to PATH operations is the unusual peaking characteristics of the ridership. Of total ridership during the day more than 2/3 travel during the peak periods designated as 7 to 10 A.M. and 4 to 7 P.M. 40% travel during the peak hours and 10% travel during the peak 15 minutes. This high peak hour patronage results in poor utilization of the PATH facilities.

Certain limitations in fleet size, platform length, allowable headways and power supply restrict the level of service which PATH can provide to its peak-hour passengers. The 46 new cars currently on order will permit the operation of eight car trains and may allow the introduction of an additional train from Newark to the World Trade Center during the peak hour.

The completion of the World Trade Center with its longer platform (550 feet) has resulted in the possible use of 10-car trains on the Newark to World Trade Center line, increasing the peak hour capacity by 67%.



EXISTING Path SYSTEM

PLATE VI-1

Train lengths on the 33rd Street line are restricted to a maximum of 7 cars because of platform lengths which vary between 349 and 382 feet. There is no currently planned program to increase the platform lengths on this line.

Headways in the tunnels are restricted to 90 seconds which when evenly split between the Hoboken and Newark service results in a minimum headway of 3 minutes on each line because of the signal system.

Speeds in the tunnels are restricted to 45 mph, further reducing the utilization of the lines.

The signal system from Journal Square to Newark must be revised and reconstructed for any schedules requiring headways lower than 2 minutes and 15 seconds.

Operating speeds between Journal Square and Newark are currently restricted because of a lack of sufficient power but the installation of a new substation should result in the reduction of 1 minute of the running time between these two stations.

In summary, the PATH system provides an excellent service for the off peak user and a reliable, if crowded, service for the peak hour commuter.

SECTION VII

RIDERSHIP FORECASTS

Presented herein are significant findings and a statement on methodology used by Wilbur Smith and Associates in forecasting usage of the proposed extension of the PATH rail system to Cranford. The objective of this portion of the study is to estimate the number of riders who would potentially be attracted to the extended system for 1980 and 1985. Estimates are presented for annual and average weekday usage of PATH for various alternative conditions. Forecasts of average weekday and peak hour station boarding and line volumes are discussed, various market segments are identified and the models used for each of these markets are described.

BACKGROUND PARAMETERS

Description of Study Area

With Newark Airport serving a regional market, the study area constitutes the entire New York metropolitan area, a radius of about 50 miles from Manhattan. However, since the PATH system will directly serve a more limited region for non-airport travel, a primary market area or corridor was identified comprising the following 20 New Jersey municipalities:

Cranford	Elizabeth
Garwood	Newark
Kenilworth	Harrison
Union	Jersey City
Springfield	Bayonne
Mountainside	Fanwood
Westfield	Scotch Plains
Clark	Linden
Winfield	Roselle
Hillside	Roselle Park

Plate IV–1 (p. 8) presents the 99 analysis zones which were used in this study and identifies the corridor. Zone configuration generally follows municipal boundaries or groups of municipalities, with finer detail in certain areas of the corridor.

Data Sources

In recent years, there have been a number of origin and destination surveys conducted which have been used as input data for model development. These include the 1963–1964 Tri-State Home Interview Survey, the 1967–1968 Newark Airport Domestic Inflight Survey, and surveys of travelers using the various trans-Hudson facilities conducted by the Port of New York Authority in 1968 and prior years. In addition, various reports and publications regarding travel patterns in the study area have been evaluated.

Planning Factors Unique to the PATH Extension

Unique to the study corridor is the existence of highly competitive rail, bus, and private modes. Also, employment locations potentially served by the PATH extension are largely defined by the corridor limits since the necessary transfers between modes for access to other areas in the region make travel times prohibitive.

Although future travelers bound for downtown Manhattan from outside the study corridor will be able to transfer to PATH at Cranford and Elizabeth from the CNJ and Penn Central railroads, very few are expected to do so; transferring to PATH at Newark will provide these passengers with travel time, cost and headway advantages.

Whereas the largest portion of Manhattan employment is focused in midtown, PATH service is best to downtown where almost 450,000 persons are employed. Today, only 2% of Newark Airport air travelers originate their trips from this area (about 400 daily). Comparatively about 4,000 daily Newark Airport passengers originate trips from the Midtown area. These are best served by existing bus transit and private modes.

For the remaining trans-Hudson and intra-New Jersey markets for the PATH extension, other transit modes are highly competitive with (in many cases) lower travel costs, comparable travel times, and similar area coverage.

All of these factors have influenced projections of patronage on the planned PATH system expansion.

Assumptions

The alternative test parameters were oriented to planning and operational aspects of Newark Airport access. Six resultant conditions for the two projection years were originally studied. These are:

1. With continuation of Carey Transportation Company bus service;
2. Without Carey bus service;
3. With a new Meadowlands STOL Port; and,
4. Without a new STOL Port;
5. With a $0.50 per person charge on the Inter-Terminal Transit (ITT) System; and,
6. Without a charge on the ITT System.

To further study the implications of these alternatives, the analysis of the impact of the PATH extension on patronage were accomplished using the following combinations of test parameters:

1. No STOL Port with Carey bus service, 1980 and 1985;
2. STOL Port with Carey bus service, 1980 and 1985;
3. No STOL Port, no Carey bus service, 1980 and 1985.

In addition, the influence of a $0.50 ITT fare on both air passengers and airport employees was examined for each of the above combinations.

GENERAL STUDY APPROACH

Due to different modal choice characteristics for the various travel groups or market segments, separate analysis methods were used for each in developing ridership estimates. For study purposes, potential riders have been stratified into the following four market segments:

1. Newark Airport air passengers;
2. Newark Airport employees;
3. Trans-Hudson travelers; and
4. Intra-New Jersey travelers.

Newark Airport Air Passengers

In developing modal split relationships air passengers were subdivided by origins, east versus west of the Hudson River, by purpose of trip, and whether or not the trip originated from their place of residence.

Newark Airport Employees

Modal split curves developed from intra-New Jersey work trip patterns and traveler characteristics were used in estimating airport employee PATH usage.

Trans-Hudson Travelers

Modal split and sub-modal split models were developed for peak and off-peak periods for this market segment. In the development of these models, trips to Manhattan were separated from trips to other destinations east of the Hudson River. Total trip interchange was estimated using current origin and destination patterns, and projected population and employment growth.

Intra-New Jersey Travelers

Using 1963 Tri-State trip records and projected population and employment figures, estimates were made of total trip interchange for this market segment. Modal split and sub-modal split models were developed and applied separately for work and non-work trip purposes.

FORECASTING MODELS

Relationships between existing travel habits and predictive factors such as travel time, cost, trip purpose, and the effect of competing travel modes, were taken into account in calibrating modal split and sub-modal split models for patronage forecasts on the extended PATH system. Composition of travelers by type of trip were further dissected to aid in categorizing trip types for further refinement and study. A series of curves graphically depicting the mathematical models developed for this project are presented in Plates VII–1 through VII–6.

Newark Airport Model

Because of flexibility and no transfers, portal-to-portal automobile travel times are less than transit travel times for Newark Airport users from most points in the region. However, because of user proximity to the Midtown Bus Terminal, travel times between Midtown Manhattan and Newark Airport are very competitive when comparing private versus public modes.

For downtown Manhattan, with transit travel times currently 8–15 minutes greater than private vehicle travel times, just under 50% of the air passengers from this area now use public transportation to and from Newark Airport. The PATH Airport access will make public and private modes comparable in travel times and the transit precentage is expected to increase.

Plate VII–1 relates the time difference in minutes between private and public modes and the proportion of persons using public transportation. Home based trips for personal reasons are least sensitive to travel time differences, as indicated by the upper curve. On the other hand, business travelers originating trips from places other than their homes are quite sensitive to relative travel time differences.

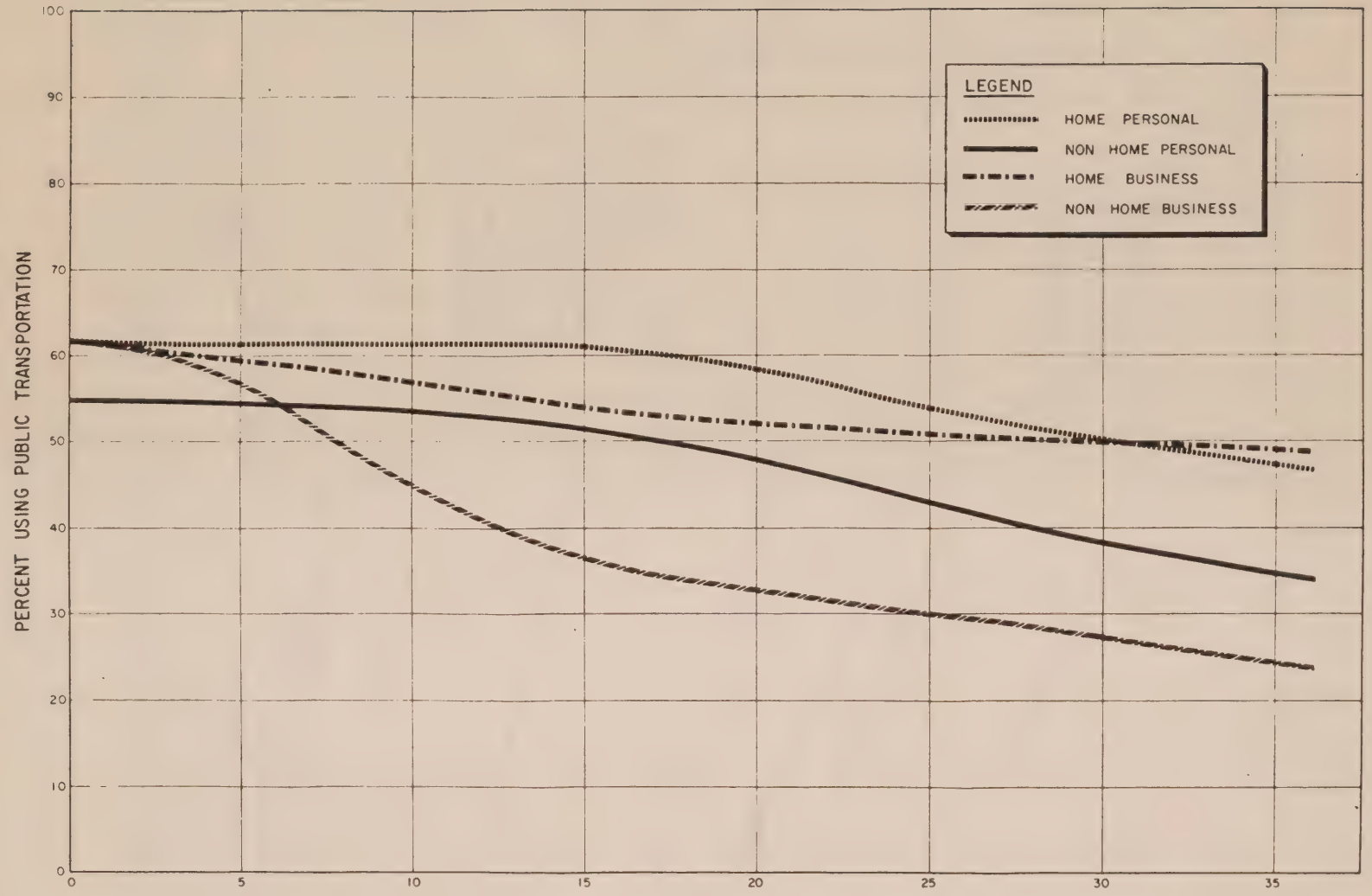
Trans-Hudson Model

A wide range of comparative costs for travel between public and private modes exists for trans-Hudson commuters. For example, tolls, parking costs, time differences, vehicle operating costs and other factors can approach $15.00 per day for an automobile trip in and out of Manhattan. This compares with an out-of-pocket cost of between $1.00 and $2.00 daily if transit (rail or bus) is utilized. Therefore, initial efforts to relate these characteristics to some type of rational modal split evaluation were difficult. Taking account of these factors, it was apparent that a model based on time and cost factors could not adequately predict future peak period auto usage, since other motivating reasons apparently influence selection of the private mode.

Therefore, for peak period analysis it was decided to use the base year percentage auto split after grouping the various destination zones into geographical areas: Midtown, Uptown, Downtown, The Valley (all parts of Manhattan), Bronx, Brooklyn, and Queens. Referencing these geographical areas to the trip origin/destination patterns from the Port of New York Authority trans-Hudson Studies of 1968, established patterns for future peak period use.

Again relating existing auto versus transit usage to the various geographic areas east of the Husdon River, modal split relationships for off-peak periods were established. The effect of travel time differences is included in these relationships, as shown in Plate VII–2. As could be expected, transit usage is highest for trips to Downtown and Midtown areas with comparatively low transit use to the Bronx, Brooklyn and Queens.

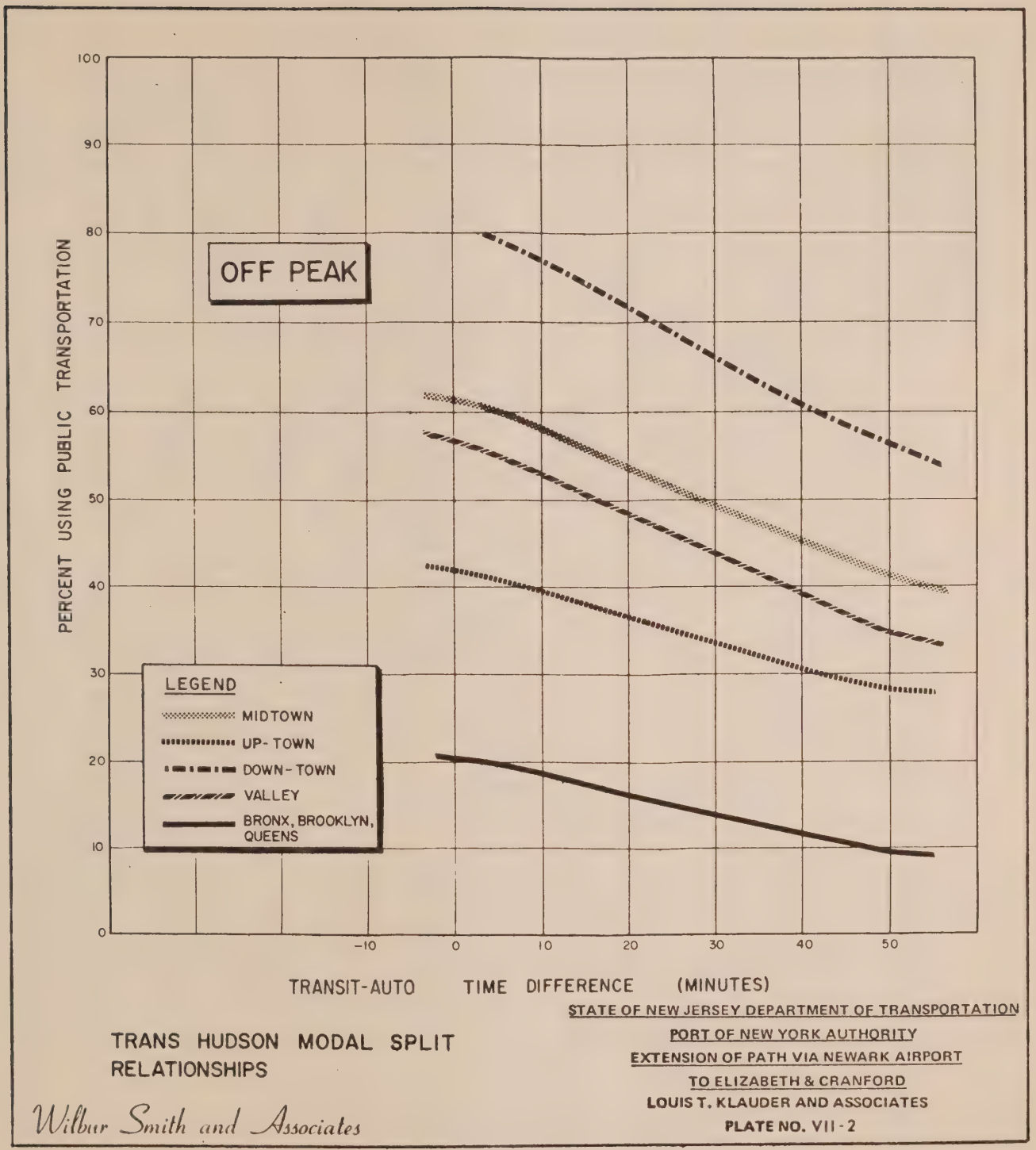
With relative travel times 15 to 35 minutes less by rail versus bus, as well as 15 to 40 cents additional cost by bus, virtually all persons during peak periods use rail to lower Manhattan. This high rail usage is reflected in the respective sub-modal split curves shown in Plate VII–3.



NEW YORK CITY TO NEWARK AIRPORT MODAL SPLIT RELATIONSHIPS

Wilbur Smith and Associates

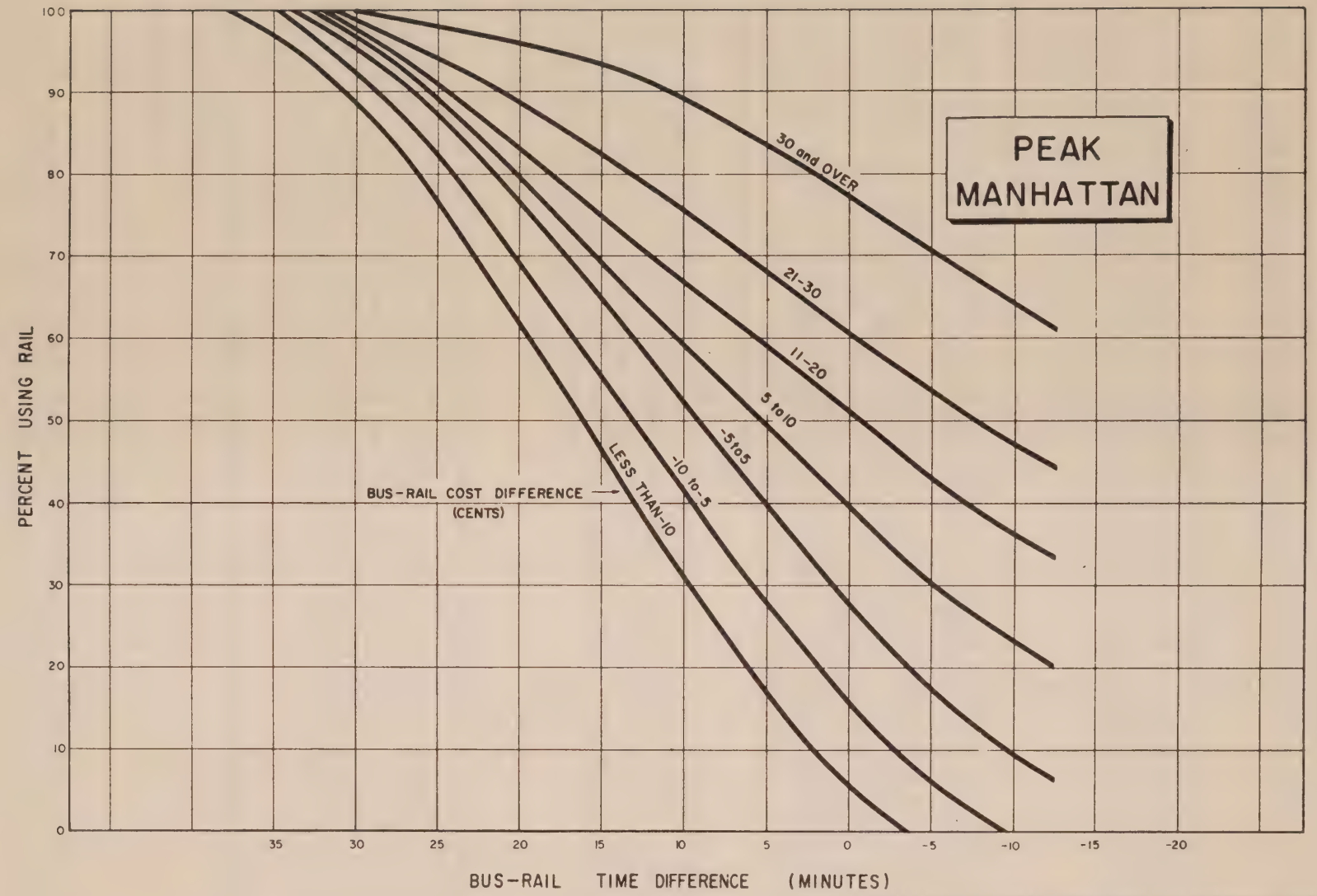
STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION
PORT OF NEW YORK AUTHORITY
EXTENSION OF PATH VIA NEWARK AIRPORT
TO ELIZABETH & CRANFORD
LOUIS T. KLAUDER AND ASSOCIATES
PLATE NO. VII-1



TRANS HUDSON MODAL SPLIT RELATIONSHIPS

Wilbur Smith and Associates

STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION
PORT OF NEW YORK AUTHORITY
EXTENSION OF PATH VIA NEWARK AIRPORT
TO ELIZABETH & CRANFORD
LOUIS T. KLAUDER AND ASSOCIATES
PLATE NO. VII - 2



TRANS HUDSON SUB MODAL SPLIT RELATIONSHIPS

Wilbur Smith and Associates

STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION
PORT OF NEW YORK AUTHORITY
EXTENSION OF PATH VIA NEWARK AIRPORT
TO ELIZABETH & CRANFORD
LOUIS T. KLAUDER AND ASSOCIATES
PLATE NO. VII-3

To Midtown, for areas in proximity to the Port Authority Bus Terminal, as well as much of the East Side, bus travel times and costs are competitive with rail. For many Midtown areas this is reflected in bus usage being higher than rail. For the Midtown area as a whole peak period rail and bus use from the study corridor are split relatively evenly.

In comparing these peak-hour curves to the off-peak sub-modal-split relationships shown in Plate VII–4 it is apparent that for equivalent time and cost differences bus usage during the off-peak is proportionately higher. This higher bus usage suggests the influence that level of service factors, and the relative cost differences, which vary between peak and off-peak, has on the decision between the two competing transit modes.

Intra-New Jersey Models

Similar to the preceding illustrations, modal split relationships based on cost and travel time factors for work and non-work purposes were developed. Modal split curves established for work trips are shown in Plate VII–5. As exhibited by these curves, with ten to thirty minutes additional travel time generally encountered when using transit versus private auto, and from ten to fifty cents additional auto cost, most persons are currently using a private vehicle for work trip purposes. With parking costs in downtown Newark considerably higher than other employment locations in the corridor, cost differences ranging between fifty cents and just over one dollar result when comparing auto and transit costs. The proportionally higher use of transit to downtown Newark is also reflected in these curves.

Because of frequent stops, and travel friction with private modes, bus travel times for many of the lines serving intra-New Jersey trips within the corridor range from five to twenty minutes additional time compared to rail travel times. However with travel costs generally less by bus, as well as in most instances service and coverage advantages, there is a bias mode exhibited in the sub-modal split curves shown in Plate VII–6.

MODEL APPLICATION

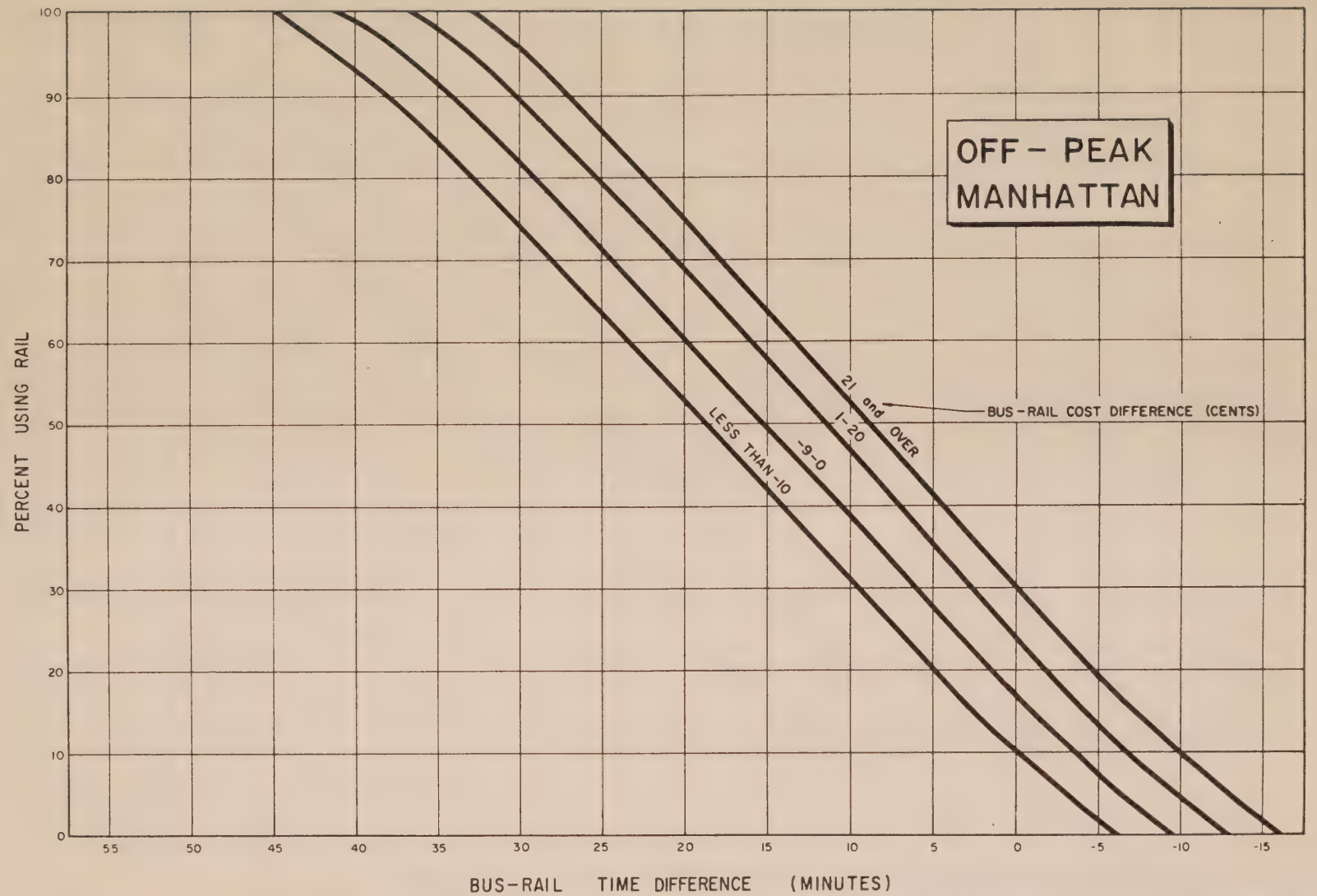
Utilizing an IBM 360–30 computer and conventional programming and traffic assignment techniques, a number of assignments were made to the PATH system employing the previously mentioned modal split relationships. These assignments were stratified by trip purpose, type of traveler, and origins and destinations for the two projection years, 1980 and 1985. Ridership figures are one-way trips, such that each leg of a two way trip is shown as a separate ride on the PATH system. For airport passengers, both enplaning and deplaning passengers using the PATH system are shown in ridership figures.

Following are the results of model application for the various assumption combinations mentioned earlier.

Airport Passengers

1. No STOLport with Carey bus service, 1980–1985

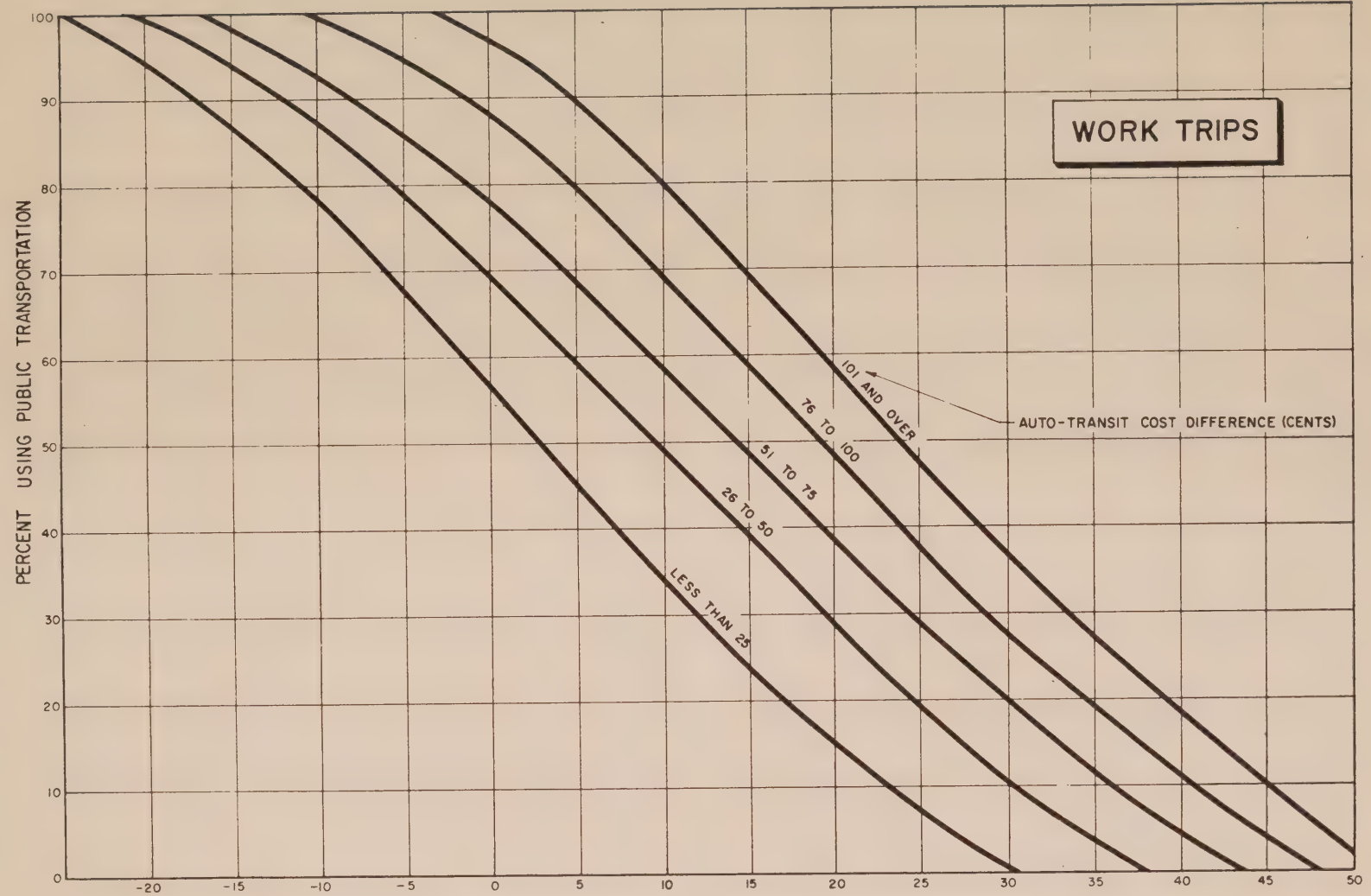
Tables VII–1 and VII–2 show the estimated number of airport passengers expected to use PATH, assuming no New Jersey STOLport and assuming continued ground access competition from Carey Transportation Company buses. It is estimated that of the total forecast metropolitan area air passenger market of 11.8 million annual air passengers, 7.9 per cent will use the PATH system by 1980. This translates into 935,000 annual air passengers, or 2,555 daily persons using PATH for airport access.



TRANS HUDSON SUB MODAL SPLIT RELATIONSHIPS

Wilbur Smith and Associates

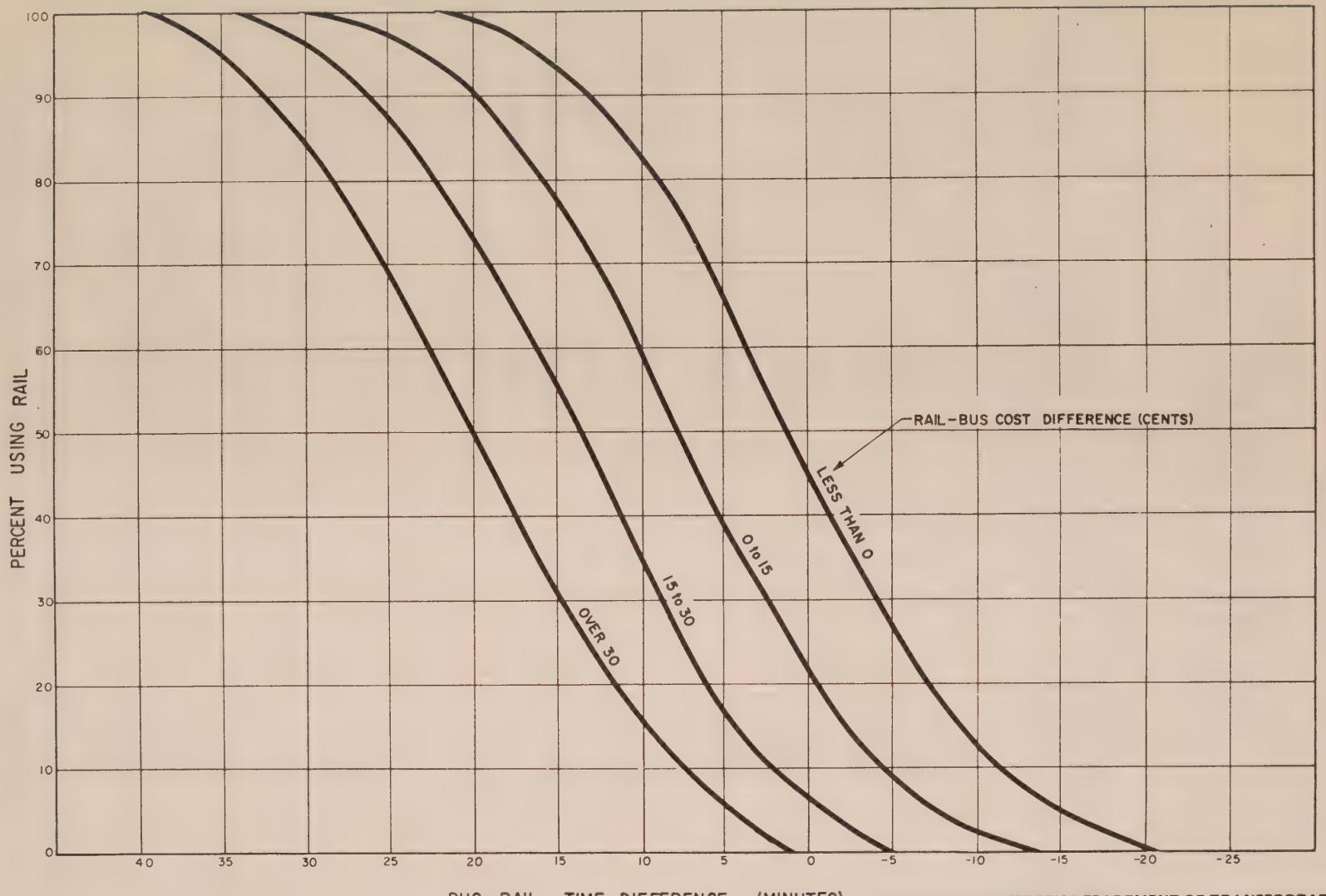
STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION
PORT OF NEW YORK AUTHORITY
EXTENSION OF PATH VIA NEWARK AIRPORT
TO ELIZABETH & CRANFORD
LOUIS T. KLAUDER AND ASSOCIATES
PLATE NO. VII-4



INTRA NEW JERSEY MODAL SPLIT RELATIONSHIPS

STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION
PORT OF NEW YORK AUTHORITY
EXTENSION OF PATH VIA NEWARK AIRPORT
TO ELIZABETH & CRANFORD
LOUIS T. KLAUDER AND ASSOCIATES
PLATE NO. VII-5

Wilbur Smith and Associates



INTRA NEW JERSEY SUB MODAL SPLIT RELATIONSHIPS

STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION
PORT OF NEW YORK AUTHORITY
EXTENSION OF PATH VIA NEWARK AIRPORT
TO ELIZABETH & CRANFORD
LOUIS T. KLAUDER AND ASSOCIATES
PLATE NO. VII - 6

Wilbur Smith and Associates

Table VII-1

ESTIMATED NUMBER OF NEWARK AIRPORT
AIR PASSENGERS USING PATH

Three Airport System, with Carey Coach

ORIGIN/ DESTINATION	1980 FORECAST YEAR Estimated Annual Air Passengers (1) (Thousands)	Estimated Per Cent Using PATH	Estimated Average Daily PATH Users	Estimated Annual PATH Users (Thousands)
East of Hudson				
Manhattan Total	3,120	18.1	1,550	570
Downtown	(190)	(51.5)	(270)	(100)
Midtown	(2,020)	(17.5)	(970)	(355)
Uptown	(910)	(12.5)	(310)	(115)
Brooklyn	280	41.6	320	115
Other	1,005	5.9	165	60
Subtotal	4,405	16.9	2,035	745
West of Hudson				
Union	1,020	8.3	225	85
Essex	880	3.1	75	25
Hudson	295	6.3	50	20
Richmond	190	-	-	-
Bergen	1,330	-	-	-
Passaic	410	-	-	-
Morris	760	-	-	-
Somerset	415	2.0	25	10
Middlesex	800	2.0	45	15
Monmouth	915	4.0	100	35
Orange-Rockland	390	-	-	-
Subtotal	7,405	2.6	520	190
TOTAL	11,810	7.9	2,555	935

(1) Provided by Port of New York Authority, Aviation Economics Division.

NOTE: Numbers in parentheses are included in "Manhattan Total."

Table VII-2

ESTIMATED NUMBER OF NEWARK AIRPORT
AIR PASSENGERS USING PATH

Three Airport System, with Carey Coach

ORIGIN/ DESTINATION	1985 FORECAST YEAR			
	Estimated Annual Air Passengers (1) (thousands)	Estimated Per Cent Using PATH	Estimated Average Daily PATH Users	Estimated Annual PATH Users (thousands)
East of Hudson				
Manhattan Total	4,520	18.2	2,260	830
Downtown	(270)	(53.6)	(395)	(145)
Midtown	(2,885)	(17.6)	(1,390)	(510)
Uptown	(1,365)	(12.7)	(475)	(175)
Brooklyn	395	41.8	450	165
Other	1,475	5.9	240	90
Subtotal	6,390	17.0	2,950	1,085
West of Hudson				
Union	1,405	7.9	300	110
Essex	1,230	2.8	95	35
Hudson	410	6.7	75	25
Richmond	265	-	-	-
Bergen	1,845	-	-	-
Passaic	565	-	-	-
Morris	1,050	-	-	-
Somerset	570	2.0	30	10
Middlesex	1,110	2.0	60	20
Monmouth	1,265	4.0	140	50
Orange-Rockland	545	-	-	-
Subtotal	10,260	2.4	705	250
TOTAL	16,650	8.0	3,655	1,335

(1) Provided by Port of New York Authority, Aviation Economics Division.

NOTE: Numbers in parentheses are included in "Manhattan Total."

It is expected this volume will increase to over 1.3 million annual, or 3,655 average day PATH passengers by 1985. At this time, total annual air traffic has been forecast by the Port of New York Authority to be 16.6 million passengers. About 80 per cent of the PATH riders have been estimated to have as their origin or destination, areas east of the Hudson River.

Of these, about 48 per cent should be oriented to Midtown Manhattan via both branches of the PATH system or the combination trip of PATH and the Penn Central Railroad. Approximately one third of the air passengers expected to use public transportation between Midtown Manhattan and Newark Airport are represented by this figure.

Because of the competitive advantage of Downtown PATH for lower Manhattan air passengers, 90 per cent of the total public transport trips between this area and the airport are expected to use PATH. However, since relatively few air passengers are projected to have origins or destinations in Downtown, the numner of potential PATH-airport users is also relatively few. Approximately 270,000 annual airport passengers are forecast to originate or terminate trips in Downtown Manhattan. This further breaks down to about 900 air passengers daily. Of these, about 50 per cent will likely use PATH to Newark Airport.

2. STOLport with Carey bus service, 1980–1985

If a STOLport is developed in the Meadowlands, it will likely attract some of the potential Newark Airport market. As projected by PONYA, a reduction in annual Newark Airport passengers is anticipated for 1980 and 1985; 11.8 million versus 9.9 million in 1980 and 16.6 million versus 14.1 million in 1985.

The impact of the STOLport on PATH volumes is projected to be a 21% decrease, or 2,010 daily passengers in 1980. The corresponding 1985 figure is 2,940 daily air passengers using PATH. These volumes are indicated in the Four Airport System totals – Tables VII–3 and VII–4.

3. No STOLport, no Carey bus service, 1980–1985

The Carey Transportation Company in 1967 served about 1,600 people daily between Manhattan and Newark Airport. About 1,200 daily airport-oriented passengers used TNJ buses.

If Carey services were discontinued, many of their existing passengers would likely transfer to TNJ facilities because of proximity to terminal locations and similarity of routes for these systems. Without Carey Coach, the PATH extension would attract about 600 more passengers by 1980 and about 1,800 more passengers by 1985. These estimates are related to total annual forecasts of airport passengers, as shwon in Tables VII–5 and VII–6.

Total PATH assignments under these assumed conditions are 3,130 daily airport passengers in 1980 and 4,425 passengers daily in 1985.

Influence of ITT Charge

The inter-terminal system will connect all new airport terminal buildings and parking facilities in a closed loop configuration. Final system equipment has not been selected, but due to car size differentials it is not feasible to utilize the same trackage or right-of-way to extend PATH into terminal buildings. Rather, a transfer station is planned on the periphery of the airport near the parking facilities.

Table VII-3

ESTIMATED NUMBER OF NEWARK AIRPORT
AIR PASSENGERS USING PATH

Four Airport System, with Carey Coach

ORIGIN/ DESTINATION	1980 FORECAST YEAR Estimated Annual Air Passengers (1) (thousands)	Estimated Per Cent Using PATH	Estimated Average Daily PATH Users	Estimated Annual PATH Users (thousands)
East of Hudson				
Manhattan Total	2,300	18.1	1,135	420
Downtown	(145)	(51.5)	(205)	(75)
Midtown	(1,415)	(17.5)	(675)	(250)
Uptown	(740)	(12.5)	(255)	(95)
Brooklyn	240	41.6	275	100
Other	785	5.9	125	45
Subtotal	3,325	17.0	1,535	565
West of Hudson				
Union	955	7.3	210	70
Essex	725	2.9	55	20
Hudson	275	6.9	50	20
Richmond	175	-	-	-
Bergen	1,070	-	-	-
Passaic	350	-	-	-
Morris	665	-	-	-
Somerset	390	2.0	20	10
Middlesex	760	2.0	40	15
Monmouth	885	4.0	100	35
Orange-Rockland	335	-	-	-
Subtotal	6,585	2.6	475	170
TOTAL	9,910	7.4	2,010	735

(1) Provided by Port of New York Authority, Aviation Economics Division.

NOTE: Numbers in parentheses are included in "Manhattan Total."

Table VII-4

ESTIMATED NUMBER OF NEWARK AIRPORT
AIR PASSENGERS USING PATH

Four Airport System, with Carey Coach

ORIGIN/ DESTINATION	1985 FORECAST YEAR Estimated Annual Air Passengers (1) (thousands)	Estimated Per Cent Using PATH	Estimated Average Daily PATH Users	Estimated Annual PATH Users (thousands)
East of Hudson				
Manhattan Total	3,405	18.2	1,700	620
Downtown	(210)	(53.6)	(310)	(115)
Midtown	(2,060)	(17.6)	(995)	(360)
Uptown	(1,135)	(12.7)	(395)	(145)
Brooklyn	340	41.8	390	140
Other	1,175	5.9	190	70
Subtotal	4,920	16.9	2,280	830
West of Hudson				
Union	1,320	7.9	285	105
Essex	1,020	2.8	80	30
Hudson	385	6.5	70	25
Richmond	245	-	-	-
Bergen	1,495	-	-	-
Passaic	490	-	-	-
Morris	925	-	-	-
Somerset	540	2.0	30	10
Middlesex	1,055	2.0	60	20
Monmouth	1,225	4.0	135	50
Orange-Rockland	480	-	-	-
Subtotal	9,180	2.6	660	240
TOTAL	14,100	7.6	2,940	1,070

(1) Provided by Port of New York Authority, Aviation Economics Division.

NOTE: Numbers in parentheses are included in "Manhattan Total."

Table VII-5

ESTIMATED NUMBER OF NEWARK AIRPORT
AIR PASSENGERS USING PATH

Three Airport System, Without Carey Coach

ORIGIN/ DESTINATION	1980 FORECAST YEAR			
	Estimated Annual Air Passengers (1) (thousands)	Estimated Per Cent Using PATH	Estimated Average Daily PATH Users	Estimated Annual PATH Users (thousands)
East of Hudson				
Manhattan	3,120	24.4	2,090	764
Downtown	(190)	(61.5)	(325)	(118)
Midtown	(2,020)	(23.6)	(1,295)	(474)
Uptown	(910)	(18.9)	(470)	(172)
Brooklyn	280	43.5	335	122
Other	1,005	6.7	185	68
Subtotal	4,405	21.6	2,610	954
West of Hudson				
Union	1,020	8.3	225	85
Essex	880	3.1	75	25
Hudson	295	6.3	50	20
Richmond	190	-	-	-
Bergen	1,330	-	-	-
Passaic	410	-	-	-
Morris	760	-	-	-
Somerset	415	2.0	25	10
Middlesex	800	2.0	45	15
Monmouth	915	4.0	100	35
Orange-Rockland	390	-	-	-
Subtotal	7,405	2.6	520	190
TOTAL	11,810	9.7	3,130	1,144

(1) Provided by Port of New York Authority, Aviation Economics Division.

NOTE: Numbers in parentheses are included in "Manhattan Totals."

Table VII-6

ESTIMATED NUMBER OF NEWARK AIRPORT
AIR PASSENGERS USING PATH

Three Airport System, Without Carey Coach

ORIGIN/ DESTINATION	1985 FORECAST YEAR Estimated Annual Air Passengers (1) (thousands)	Estimated Per Cent Using PATH	Estimated Average Daily PATH Users	Estimated Annual PATH Users (thousands)
East of Hudson				
Manhattan	4,520	24.0	2,965	1,075
Downtown	(270)	(61.5)	(455)	(166)
Midtown	(2,885)	(23.1)	(1,835)	(670)
Uptown	(1,365)	(18.0)	(675)	(246)
Brooklyn	395	43.5	470	172
Other	1,475	7.2	290	106
Subtotal	6,390	22.8	3,725	1,353
West of Hudson				
Union	1,405	7.9	300	110
Essex	1,230	2.8	95	35
Hudson	410	6.7	75	25
Richmond	265	-	-	-
Bergen	1,845	-	-	-
Passaic	565	-	-	-
Morris	1,050	-	-	-
Somerset	570	2.0	30	10
Middlesex	1,110	2.0	60	20
Monmouth	1,265	4.0	140	50
Orange-Rockland	545	-	-	-
Subtotal	10,260	2.4	700	250
TOTAL	16,650	9.6	4,425	1,603

(1) Provided by Port of New York Authority, Aviation Economics Division.

NOTE:Numbers in parentheses are included in "Manhattan Totals."

Impact of this added transfer between rail systems will likely discourage, to some extent, selection of PATH as an airport mode, especially for travelers with baggage.

Tentative plans are to charge all passengers $0.50 to ride the ITT system. These charges would be assessed each rider, whether an air traveler, visitor, or employee. The result of making this charge is likely to have little, if any, effect on air travelers and visitors to Newark Airport. However, it will probably discourage employee use of the micro-system.

By 1980, about 6,500 airport employees are forecast. Of these, about 3,300 will work in airport locations conveniently served by extended PATH. If no charges are made on the ITT system, 940 employee trips are expected on PATH daily. This figure will likely increase to 1,185 by 1985, under the assumed conditions. Approximately 8,500 total airport employees are projected by 1985.

If a charge is imposed for use of the ITT system, fewer employees will be attracted. By 1980, it is expected 780 employee passenger trips would be served on the PATH system as contrasted with 980 in 1985. In making these estimates, only a three airport system (no STOLport) is anticipated.

Trans-Hudson Travel

There were about 140,000 one-way person trips made in 1968 on the PATH system. Approximately 90 per cent of this patronage crosses the Hudson River. Almost 40,000 person trips crossing the River via all modes were from the study corridor. Of these, 8,000 were served by PATH.

By 1980, it is projected that 44,275 one-way person trips will daily emanate to and from the corridor crossing the River. This compares with 47,000 trips by 1985.

Approximately 22 per cent (9,350) of the total daily trans-Hudson travelers are expected to use the PATH system. However, only about half of these (5,000) are estimated to use the PATH extension, the other half continuing existing travel patterns utilizing New Jersey Central or Penn Central Railroads and transferring to PATH at Newark. The high usage of alternative rail to PATH is partially explained by inclusions in these figures of several municipalities which are only indirectly served by the PATH extension. These municipalities include Westfield, Scotch Plains, Fanwood, Mountainside, Linden and Springfield. Residents from these communities were included because of their potential attraction to the proposed Garden State Parkway pard-and-ride facility. A further explanation for the continued usage of alternative rail options is the relatively high zone fare level assumed for the PATH extension, when compared to competitive commuter rail fares.

On the positive side, there is a two- to three-minute average travel time savings, when using PATH, a figure which includes a transfer time saving. Another advantage is that the extension offers the trans-Hudson commuter opportunity to avoid the Newark Penn Station transfer. Further, a greater likelihood of getting a seat on the eastbound journey, with a more reliable service and uniform train headways is advantageous when compared to alternative rail facilities.

On a typical weekday, in off-peak periods, the number of riders estimated to use the PATH extension is 1,350 in 1980 and 1,410 by 1985. During off-peak periods PATH fares will be equal or lower than New Jersey Central and Penn Central Railroad one-way and round trip fares. Combined with the extension's relatively frequent off-peak service at 20-minute headways, it is expected that some persons using alternative modes – particularly those persons who would have used the New Jersey Central with a transfer to PATH at Newark – would likely be diverted to this improved service. These figures are indicated in Table VII–7.

Intra-New Jersey Travel

A summary of projected one-way person trips on an average weekday for the intra-New Jersey market segment of the PATH extension is present in Table VII–8. During weekdays in 1980, it is expected that about 75,000 one-way person trips will be made between Northern New Jersey points served by the extended PATH system. By 1985, total person trips are anticipated to approach 79,000 per average weekday. About 55 per cent of these trips will likely be made for work purposes. Private vehicles are expected to be used to serve 76 per cent of the daily travel between home and work. Automobiles should serve a slightly higher proportion of non-work trips.

On an average weekday, just over 5,000 daily one-way person trips are expected to be served by extended PATH for intra-New Jersey travel in 1980, with about 5,300 one-way person trips on the extended system by 1985. For work purposes, about 30 per cent of the total public transportation trips are estimated to be made on the extended PATH system, with 53 per cent by bus and 17 per cent by other rail. The predominant work trip destinations are Newark with 45 per cent, and Elizabeth with 26 per cent.

PATRONAGE FORECASTS

Relating total daily trips in the study corridor to a proposed physical rail system (extended PATH) has given person trip (one-way) assignments for 1980 and 1985, daily and peak hourly, assuming a three-airport system with and without Carey bus service. The maximum number of daily one-way person trips forecast for the PATH extension is 16,300 by 1985 assuming no Carey bus service. Figures for other combinations of relative access service are given in Table VII–9.

Line and station volumes of one-way daily person trips between Cranford and Manhattan (PATH uptown station at 33rd Street and the Hudson Terminal station) are given in Plates VII–7 and VII–8 for 1980 and 1985, respectively. Shown in these figures are all Newark Airport one-way person trips (air passengers and employees) expected on the PATH system. For the intra-New Jersey and trans-Hudson markets only trips with at least one trip end at a PATH station west of Newark are included in the figures. Persons boarding the New Jersey Central or Penn Central and transferring to PATH at Newark are therefore not reflected in these assignments. The largest line volume of travel occurs between Newark Airport and South Street with 9,935 trips. Least number of trips on the extension will likely occur on the western extremity between the Garden State Parkway Station and Cranford (2,415 trips).

Table VII-7

ESTIMATED TRANS-HUDSON PERSON TRIPS BY MODE
Potential Market Area (1)

1980-1985

MODE	AVERAGE WEEKDAY PERSON TRIPS 1980 Number	1980 Per Cent	1985 Number	1985 Per Cent
Peak Period (2)				
Auto	3,065	13.8	3,140	13.2
Bus	5,955	26.6	6,595	27.7
Rail Modes				
PATH Extension	3,630	16.2	3,925	16.5
Other PATH	3,845	17.2	4,095	17.2
Subtotal PATH	7,475	33.4	8,020	33.7
Other Rail	5,860	26.2	6,010	25.4
Subtotal	13,335	59.6	14,030	59.1
TOTAL	22,355	100.0	23,765	100.0
Non-peak Period				
Auto	14,585	66.6	15,365	66.6
Bus	3,845	17.5	4,045	17.5
Rail Modes				
PATH Extension	1,360	6.2	1,410	6.1
Other PATH	490	2.2	550	2.4
Subtotal PATH	1,850	8.4	1,960	8.5
Other Rail	1,640	7.5	1,720	7.4
Subtotal	3,490	15.9	3,680	15.9
TOTAL	21,920	100.0	23,090	100.0
GRAND TOTAL	44,275		46,855	
Total PATH Trips:				
Average Weekday	4,990		5,335	
Average Annual	1,397,200		1,493,800	

(1) Potential market area for PATH extension.
(2) Includes trips made during 6:00 to 10:00 A.M. and 4:00 to 7:00 P.M., in major direction of travel, only.

Table VII-8

ESTIMATED INTRA-NEW JERSEY PERSON TRIPS BY MODE
Potential Market Area

1980-1985

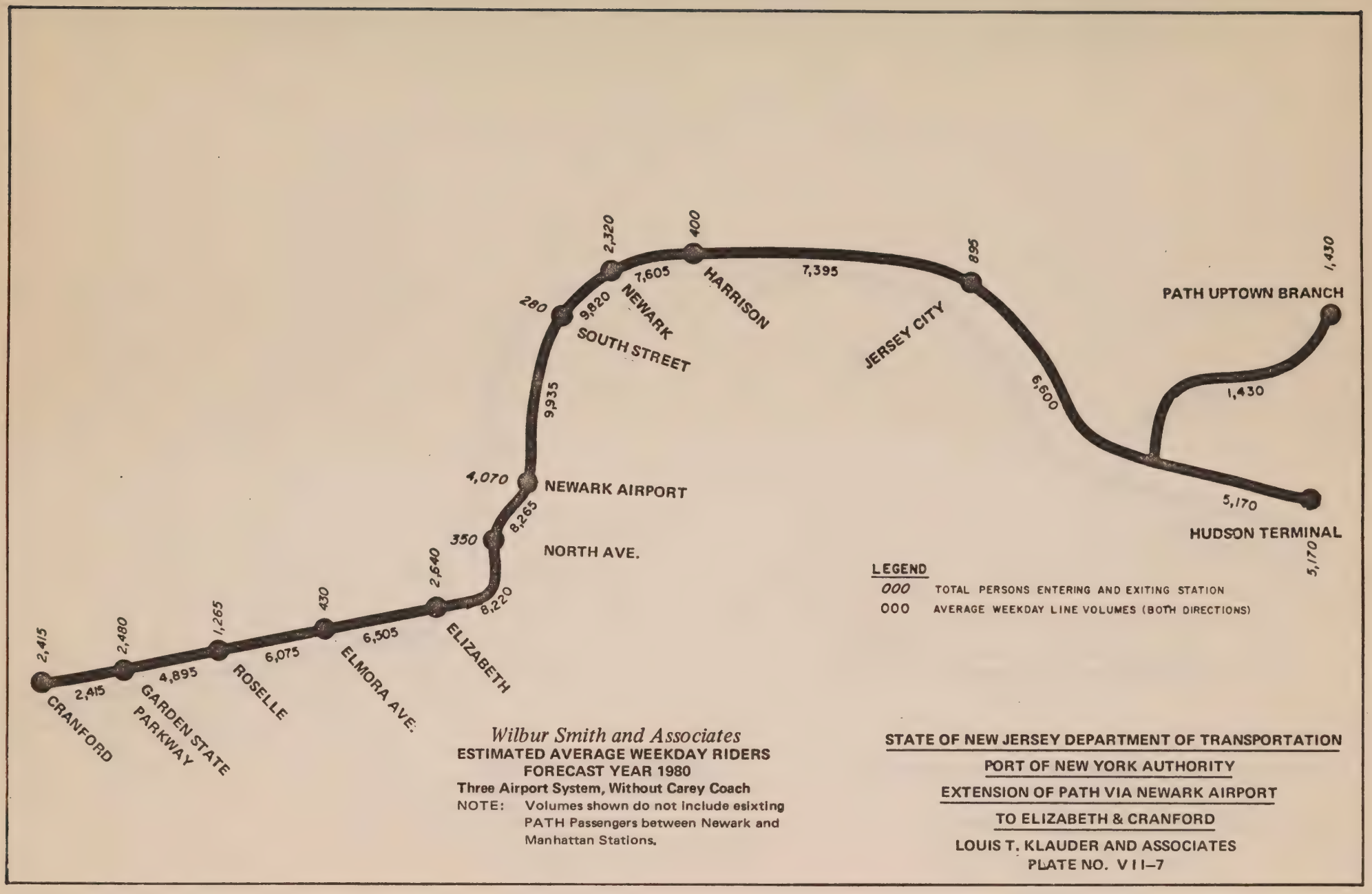
MODE	AVERAGE WEEKDAY WORK TRIPS 1980 Number	1980 Per Cent	1985 Number	1985 Per Cent
Work Trips				
Auto	30,960	76.0	31,940	76.0
Bus	5,175	12.7	5,350	12.7
Rail Modes				
PATH	2,920	7.2	3,065	7.3
Other Rail	1,665	4.1	1,675	4.0
Subtotal	4,585	11.3	4,740	11.3
TOTAL	40,720	100.0	42,030	100.0
Non-Work Trips				
Auto	26,640	78.0	28,515	77.9
Bus	4,895	14.3	5,345	14.5
Rail Modes				
PATH	2,110	6.3	2,280	6.2
Other Rail	490	1.4	510	1.4
Subtotal	2,600	7.7	2,790	7.6
TOTAL	34,135	100.0	36,650	100.0
GRAND TOTAL	74,855		78,680	
Total PATH Extension Trips:				
Average Weekday	5,030		5,345	
Average Annual	1,408,400		1,496,600	

Table VII-9

SUMMARY OF ESTIMATED AVERAGE WEEKDAY
PATH EXTENSION RIDERSHIP

ALTERNATIVE[1]	FORECAST YEAR 1980	1985
1. Three Airport System, without Carey Coach	14,090	16,300
2. Three Airport System, with Carey Coach	13,515	15,530
3. Four Airport System, with Carey Coach	12,845	14,655
4. Four Airport System, with Carey Coach and Inter-Terminal Transit Charge	12,705	14,480

(1) Alternatives 1-3 assume no I.T.T. Charge.


2,415
2,480
1,265
430
2,640
8,220
8,265
350
4,070
9,935
280
9,820
2,320
7,605
400
7,395
895
6,600
1,430
1,430
5,170
5,170
2,415
4,895
6,075
6,505
CRANFORD
GARDEN STATE PARKWAY
ROSELLE
ELMORA AVE.
ELIZABETH
NORTH AVE.
NEWARK AIRPORT
SOUTH STREET
NEWARK
HARRISON
JERSEY CITY
PATH UPTOWN BRANCH
HUDSON TERMINAL
LEGEND
000 TOTAL PERSONS ENTERING AND EXITING STATION
000 AVERAGE WEEKDAY LINE VOLUMES (BOTH DIRECTIONS)
Wilbur Smith and Associates
ESTIMATED AVERAGE WEEKDAY RIDERS
FORECAST YEAR 1980
Three Airport System, Without Carey Coach
NOTE: Volumes shown do not include esixting PATH Passengers between Newark and Manhattan Stations.
STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION
PORT OF NEW YORK AUTHORITY
EXTENSION OF PATH VIA NEWARK AIRPORT
TO ELIZABETH & CRANFORD
LOUIS T. KLAUDER AND ASSOCIATES
PLATE NO. VII–7

LEGEND

000 TOTAL PERSONS ENTERING AND EXITING STATION

000 AVERAGE WEEKDAY LINE VOLUMES (BOTH DIRECTIONS)

Wilbur Smith and Associates

ESTIMATED AVERAGE WEEKDAY RIDERS
FORECAST YEAR 1985
Three Airport System, Without Carey Coach

NOTE: Volumes shown do not include existing PATH Passengers between Newark and Manhattan Stations.

STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION

PORT OF NEW YORK AUTHORITY

EXTENSION OF PATH VIA NEWARK AIRPORT

TO ELIZABETH & CRANFORD

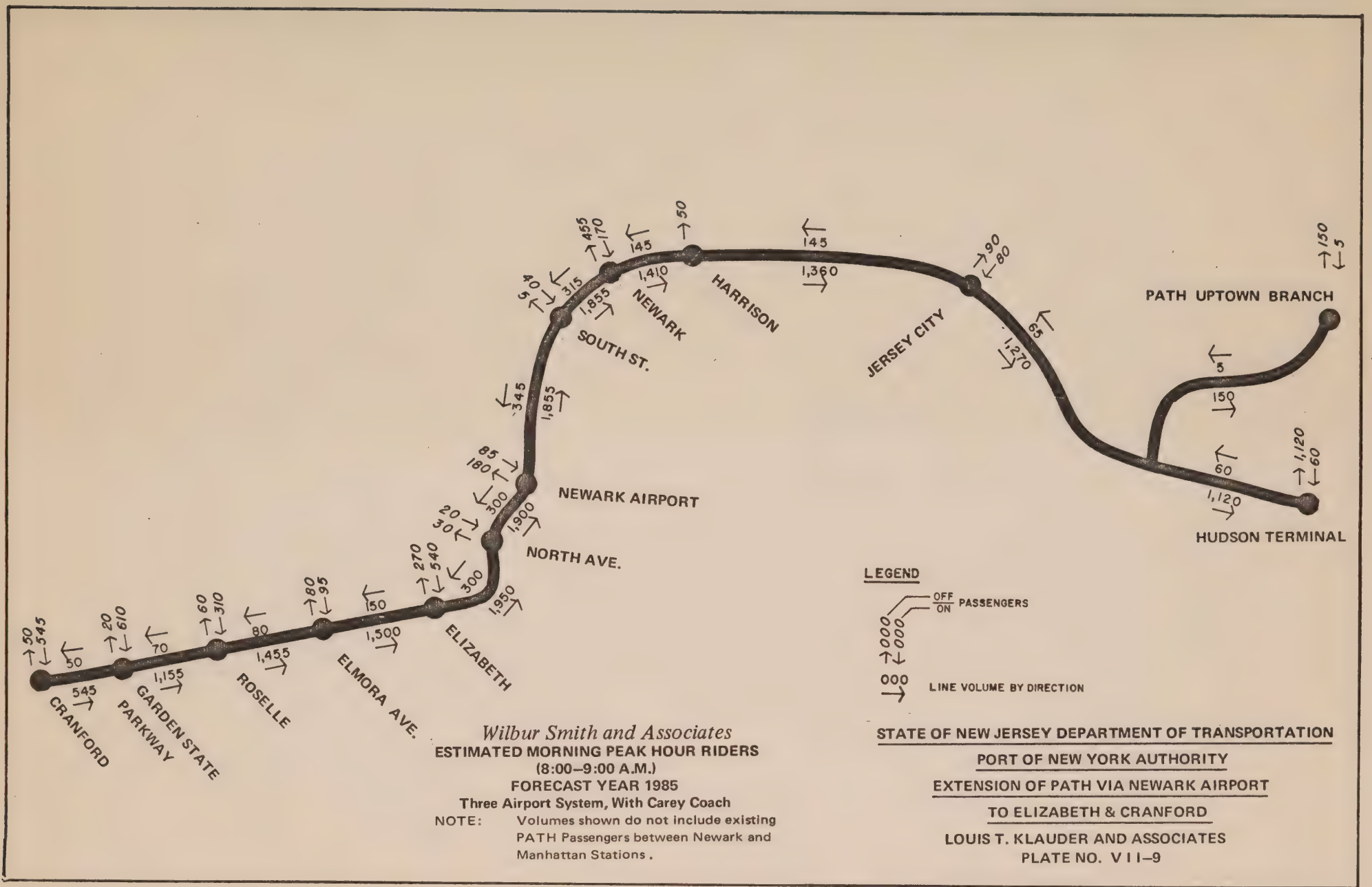
LOUIS T. KLAUDER AND ASSOCIATES
PLATE NO. V I I–8

The station having largest volumes daily is Newark Airport with 4,070 person trips. South Street is forecast to have the fewest number of trips (280).

By 1985 the Newark Airport–South Street link should serve 11,645 daily person trips and 5,640 person trips are expected daily through the Newark Airport Station.

Peak hour morning and afternoon travel for 1985 is presented in Plates VII–9 and VII–10, respectively. These were developed combining existing and projected travel characteristics of each of the four market segments.

(This section contributed by Wilbur Smith and Associates)

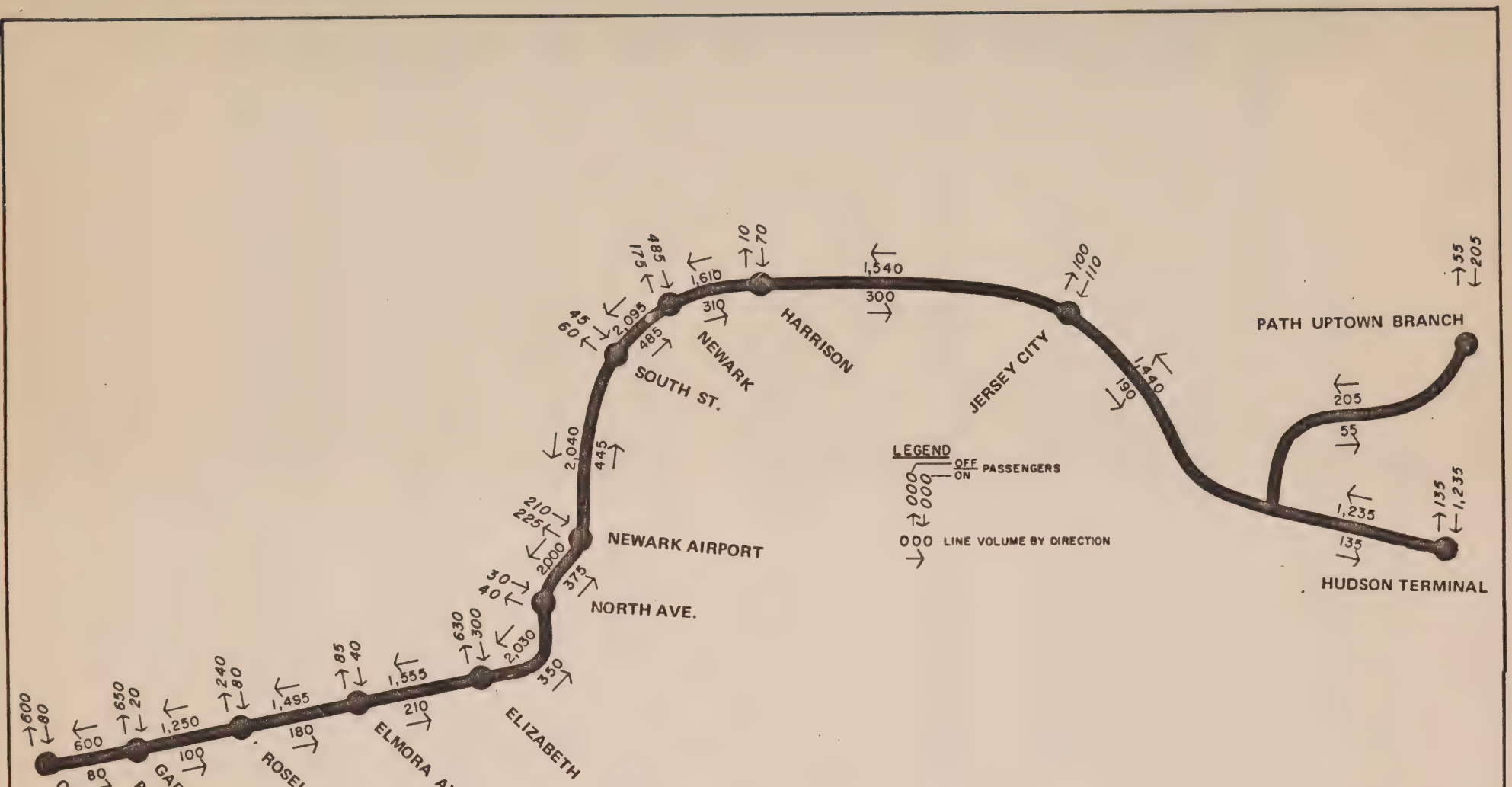


Wilbur Smith and Associates

ESTIMATED MORNING PEAK HOUR RIDERS
(8:00–9:00 A.M.)
FORECAST YEAR 1985
Three Airport System, With Carey Coach

NOTE: Volumes shown do not include existing PATH Passengers between Newark and Manhattan Stations.

STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION
PORT OF NEW YORK AUTHORITY
EXTENSION OF PATH VIA NEWARK AIRPORT
TO ELIZABETH & CRANFORD
LOUIS T. KLAUDER AND ASSOCIATES
PLATE NO. V I I–9



Wilbur Smith and Associates

ESTIMATED AFTERNOON PEAK HOUR RIDERS
(5:00–6:00 P.M.)
FORECAST YEAR 1985
Three Airport System, With Carey Coach

NOTE: Volumes shown do not include existing PATH Passengers between Newark and Manhattan Stations.

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PORT OF NEW YORK AUTHORITY
EXTENSION OF PATH VIA NEWARK AIRPORT
TO ELIZABETH & CRANFORD
LOUIS T. KLAUDER AND ASSOCIATES
PLATE NO. VII–10

SECTION VIII

SUMMARY OF THE PROPOSED SYSTEM

ALTERNATIVES STUDIED

Three location alternatives were considered for the routes between Newark station and Airport, the station in the Airport complex, the route within the Airport complex, and the route between the Airport and Elizabeth station. Newark station, the Airport terminal complex, and tracks of the Central Railroad of New Jersey in Elizabeth are the significant points controlling alignment of the extension which, as assigned by the State of New Jersey, connects PATH to stations at the Airport, North Avenue in Elizabeth, and points along the Central Railroad between Elizabeth station and Cranford station. The station location within the Airport was a major determinant of routes north and south.

The major obstacle to the PATH extension is formed by Penn Central's Waverly freight yard and the large Route 1–9 traffic interchange now under construction at the new Airport entrance.

Extension of PATH along Penn Central tracks, to Route 21 and thence by a tunnel crossing the north throat of Penn Central's Waverly yard forms an ideal route containing no operating restrictions. This PATH route could then skirt along the east side of Waverly yard and cross on viaduct over industrial properties and the Airport highway interchange to enter Airport property near the center of the terminal complex. However, location of the elevated route within Airport property interfered with the projected flight path of a possible STOL strip planned by the Port Authority.

Other solutions for this section of route included, (1) a PATH tunnel crossing in the center of Waverly yard, (2) juxtaposition of PATH and Penn Central tracks to place PATH east of the railroad just south of Newark station, and (3) an overhead crossing at the south end of Waverly yard.

The first two proved geometrically impossible or unduly expensive and the last was selected and forms the recommended route as shown on the route map, Appendix A.

Three considered route locations between the Airport and Elizabeth station were (1) elevated structure along the median of Route 1–9 (2) a re-crossing of the Penn Central Railroad near North Avenue and then south along Penn Central right-of-way; and (3) a line southeastward along Dowd Avenue and southward through mostly unimproved industrial properties to the Elizabethport yard of CNJ.

The first two routes are judged to provide an alignment superior for transit operations. However, both required the taking of residential properties and the New Jersey Department of Transportation objected to them as damaging to the community. The Dowd Avenue route was therefore selected as shown in the route map.

SUMMARY OF OPERATIONS

Two alternative operating schedules were selected for testing the response of future riders to changes in service levels. The basic service will provide trains between Newark Airport and the World Trade Center according to the schedule in Table VIII – 1 a., plus service to Cranford as shown in Table VIII – 1 b.

An expanded service would add a direct connection between the airport and Midtown Manhattan via the 33rd Street line as shown in Table VIII – 1 c. This expanded service would reduce the travel time slightly and eliminate a transfer at Journal Square.

Airport passengers will transfer between the Airport ITT and PATH within an enclosed interface station to insure comfort during the brief wait for the connecting mode in all types of weather. Escalators will reduce the inconvenience of changing levels, made necessary by the operational complications of a single level, cross platform station.

The ITT schedule will be adjusted to minimize waiting time at the PATH station during those hours when ITT service is below the usual daytime schedule of 2 minute headways in each direction.

TABLE VIII – 1
PROPOSED SCHEDULES FOR PATH EXTENSION

(a) NEWARK AIRPORT TO WORLD TRADE CENTER/ 26 MIN.

	Starting At	Trains Run Every
Monday	5:29 a.m.	10 minutes
to	7:26	6 "
Friday	9:09	10 "
	4:07 p.m.	6 "
	5:49	10 "
	9:29	20* "
	11:50	30 "
	4:49 a.m.	20 "
Saturday,	5:00 a.m.	20 "
Sunday &	9:00 a.m.	10 "
Holidays*	8:00 p.m.	20 "
	12:00 Midnight	30 "

(b) CRANFORD TO WTC/41 MIN.

	Starting At	Trains Run Every
Monday	5:23 a.m.	20 minutes
to	7:16	12 "
Friday	8:53	20 "
	3:51 p.m.	12 "
	5:43	20* "
	11:34 p.m. – 12:34 a.m.	30 "
	12:34 a.m. – 4:53 a.m.	(No Service)
	4:53 a.m.	30 "
Saturday,	5:04 a.m.	20 "
Sunday &	9:04 a.m.	10 "
Holidays*	7:44 p.m.	20 "
	11:44 p.m.	30 "
	12:44 a.m. – 4:53 a.m.	(No Service)

(c) NEWARK AIRPORT TO 33rd STREET/34 MIN.

	Starting At	Trains Run Every
Monday	6:31 a.m.	10 minutes
to	7:21	6 "
Friday	8:51	10 "
	4:45 p.m.	6 "
	5:21	10 "
	8:51 – 11:32	20* "
	11:57	30 "
	4:51 a.m.	20 "
Saturday,	5:10 a.m.	20 "
Sunday &	9:05 a.m.	10 "
Holidays*	8:10 p.m.	20 "
	12:15 a.m.	30 "

* Change to existing PATH Schedule required.

SECTION IX

IMPACT ON CORRIDOR LAND USE

The extension will not produce significant changes in land use along its corridor. No abrupt difference in land use in the outer or suburban areas can be expected because four of the five PATH stations in this region will utilize sites at existing railroad stations. Some stimulation to growth can be expected in the form of long term development of residential and service type commercial facilities near these stations. However, predominant use of autos for the home-to-station trip will prohibit the intensity of station oriented land development which was prevalent during early CNJ service.

The stations may focus development of employment activities along the extension. This would result from the present tendency to suburban location of commercial-industrial enterprise and provision of frequent two directional passenger service.

ACQUISITION OF PROPERTY

Approximately 99 acres of improved and unimproved land must be acquired for the extension's right-of-way, yards, stations and parking lots. Approximately seven acres additional must be acquired for railroad facilities which will be relocated.

Of this amount, 98 acres are suitable for or now used for industrial purposes including railroad operations, seven acres are used for commercial purposes and 0.3 acre is unimproved residential property. No dwellings will be affected.

Columns of six viaduct bents will be located within the unused portion of a cemetery on its property line with an adjacent industrial plant.

The following improved property is included in the acreage required for PATH right-of-way:

Two old machine shop type buildings in poor condition. These are now used for miscellaneous industrial purposes.
One modern high-bay industrial building and associated offices.
Four modern large low-bay multi-tenant light industrial-commercial building with interior office space.
One old factory building converted from a railroad round house.
Three quick-service type restaurant or beverage stands.
One restaurant.
One gasoline station.
One auto repair garage.
One retail store.
Three railroad passenger station buildings.

The PATH viaduct will also pass over approximately 13 acres of highway right-of-way and Newark Airport property.

ENVIRONMENTAL IMPACT

Construction of the extension will have little detrimental aesthetic effect throughout its length. The entire line is located on existing transportation corridors or in industrial areas. The sections through residential areas will require widening of the railroad right-of-way at only three points and will generally improve the appearance of the right-of-way.

Operation of the electric trains on welded rail will produce noise levels well below those of highway vehicles and diesel powered passenger or freight trains.

SECTION X

THE PROPOSED EXTENSION

CRITERIA FOR DESIGN

Roadway

Our project assignment specified that we design the roadway structures for use of PATH type transit cars and suburban service railroad multiple-unit cars. Specific criteria established for roadway design is as follows:

Train speed, maximum	70 mph
Service braking rate	3.0 mph per sec.
Curvature, running track, max.	3 degrees
Curvature, along platforms, normal	0°–30'
Curvature, along platforms, max.	1°–40'
Curvature, max.	250'R(D=23°)
Superelevation, max., unrestricted zones	7 inches
Superelevation, max., restricted zones	6 inches
Superelevation at platforms, max.	1/2 inch
Unbalance on curves, max.	3–1/2 inches
Switch and frog size, main line, normal	No. 20
Switch and frog size, main line, min.	No. 12
Switch and frog size, yard, normal	No. 10
Switch and frog size, yard, min.	No. 6
Tangent length between reverse spirals, high speed section, minimum	110 feet
Tangent length between reverse curves in yards, minimum	20 feet
Spiral length, desirable	L = 1.63 E(u) x V *
Spiral length, minimum	L = 1.22 E(u) x V *
Grade, maximum if less than 500 ft.	5%
Grade, maximum if over 500 ft.	4%
Vertical curve length	Centripetal acceleration –1.29

* or L = 62 E(a) if greater.

Vehicle weights (loaded) for undergrade structure:

a) 91,000 No, 33 ft. truck center, 6'–10" wheelbase for PATH type car
b) 155,000 No., 59'–6" truck center, 8'–6" wheelbase for railroad m-u passenger car.
c) 160,000 No., 20 ft. truck center, 6 ft. wheelbase for work train locomotive restricted to 10 mph maximum speed.

Track gage, nominal	4'–8–1/2"
Track center, nominal, running track	14'–0"
Track center, minimum, running track	13'–6"
Track center min. yard	13'–0"
Track center, PATH to adjacent railroad, minimum	13'–6"
Clearance, horizontal, to wayside structure, normal	10'–0"
Clearance, horizontal, to wayside structure, min.	8'–0"
Clearance, horizontal, in tunnel	8'–0"(1)
Clearance at platform	6 in.(2)
Clearance, vertical, minimum – east of Newark storage yard	14'–0"(3)
Clearance, vertical, minimum – west of Newark storage yard	17'–4"(4)

Traction Power System

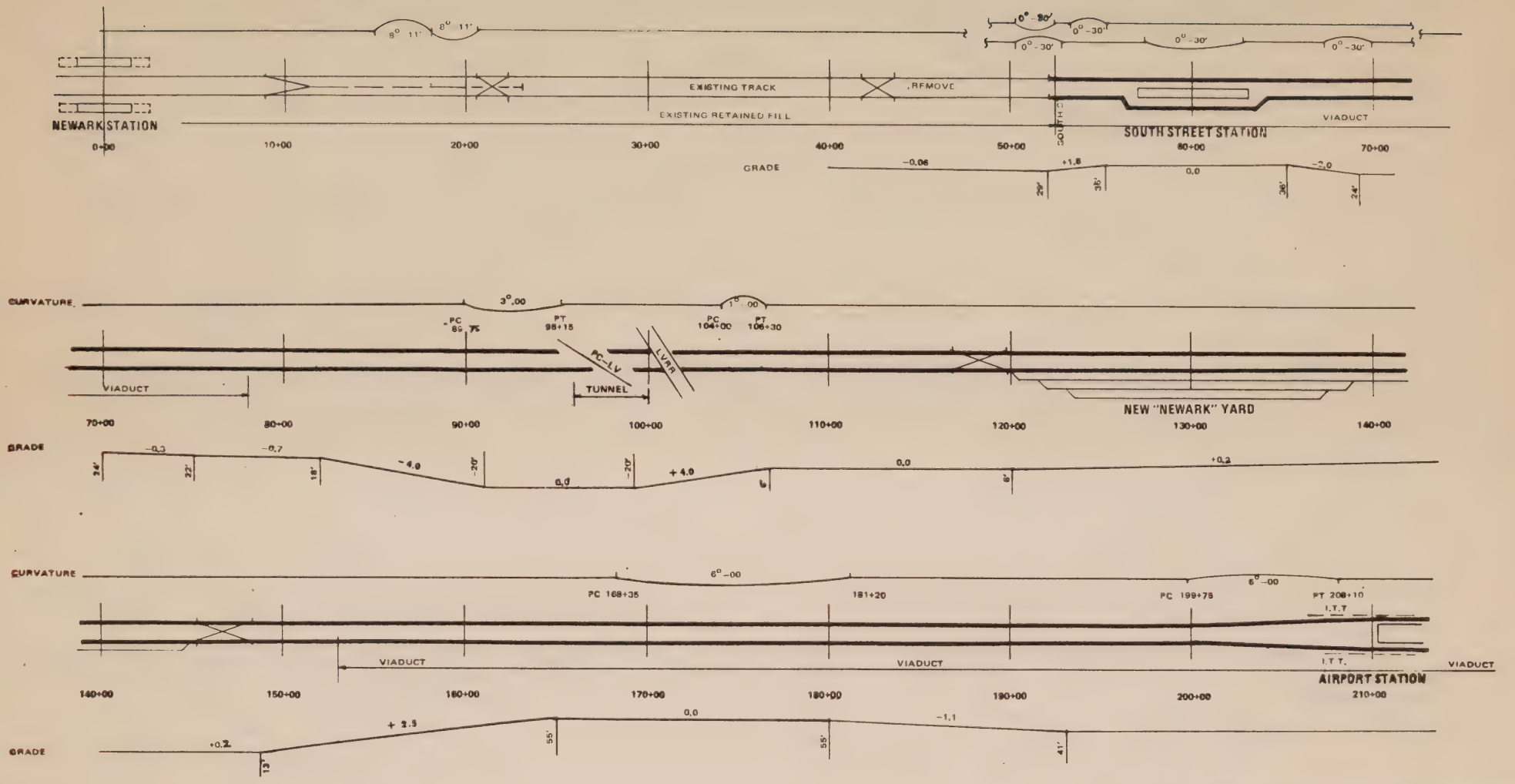
Design of the traction power system assumes use of the existing 600 volt D.C. PATH system.

The following criteria governed:

Voltage at contact rail, nominal	650 volts
Voltage at contact rail, maximum	700 volts
Voltage at contact rail, minimum	500 volts
Contact rail feed points per substation	one
Contact rail & distance from gage point	26 inches
Top of contact rail above top of running rail	4 inches
Contact rail gap length, maximum	95 feet
Substation source power	Local transmission or high voltage distribution network of Public Service Electric and Gas Company. Two circuits must be provided to feed each substation.

---

(1) To be increased along curves by use of chord calculation based on 85-foot car body and 59'–6" truck center.
(2) Used on 8'–8-1/8" floor level car body width.
(3) Based on PATH car.
(4) Based on railroad type m-u car and catenary clearance for 25 KV trolley voltage.



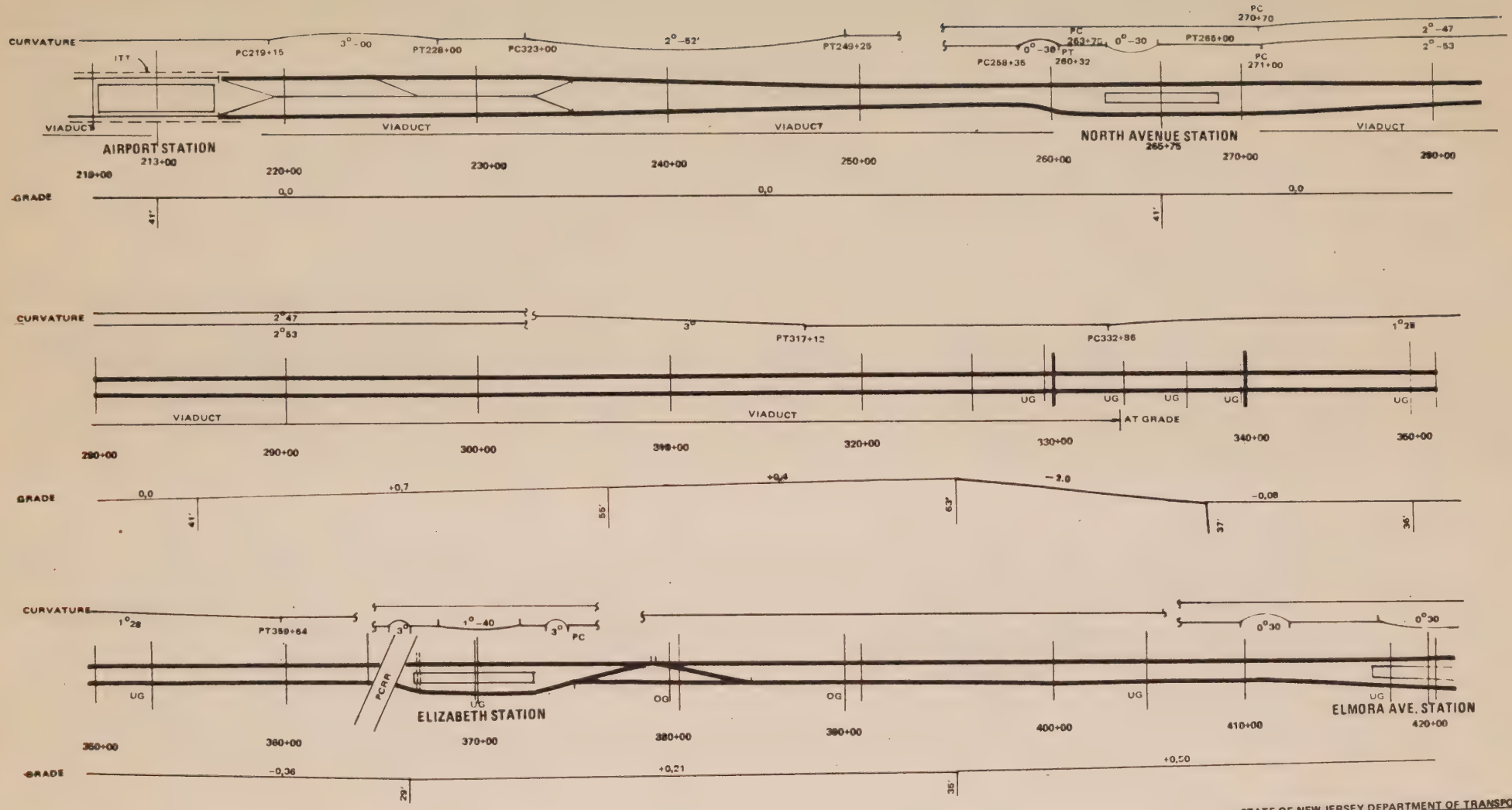
STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION
PORT OF NEW YORK AUTHORITY

EXTENSION OF PATH VIA NEWARK AIRPORT
TO ELIZABETH & CRANFORD

TRACK CHART

LOUIS T. KLAUDER AND ASSOCIATES

PLATE NO. X-5A



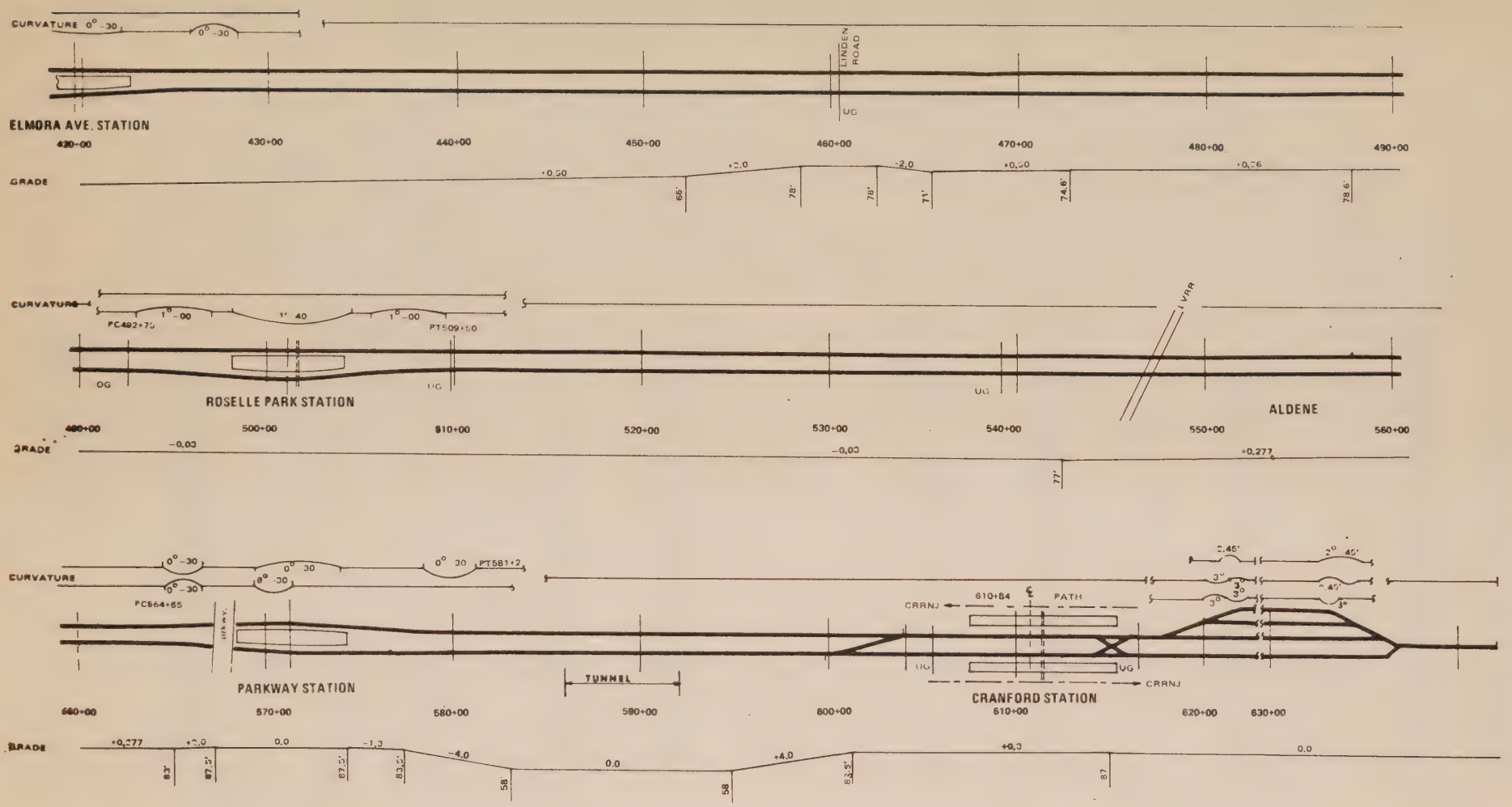
STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION
PORT OF NEW YORK AUTHORITY

EXTENSION OF PATH VIA NEWARK AIRPORT
TO ELIZABETH & CRANFORD

TRACK CHART

LOUIS T. KLAUDER AND ASSOCIATES

PLATE NO. X-5B



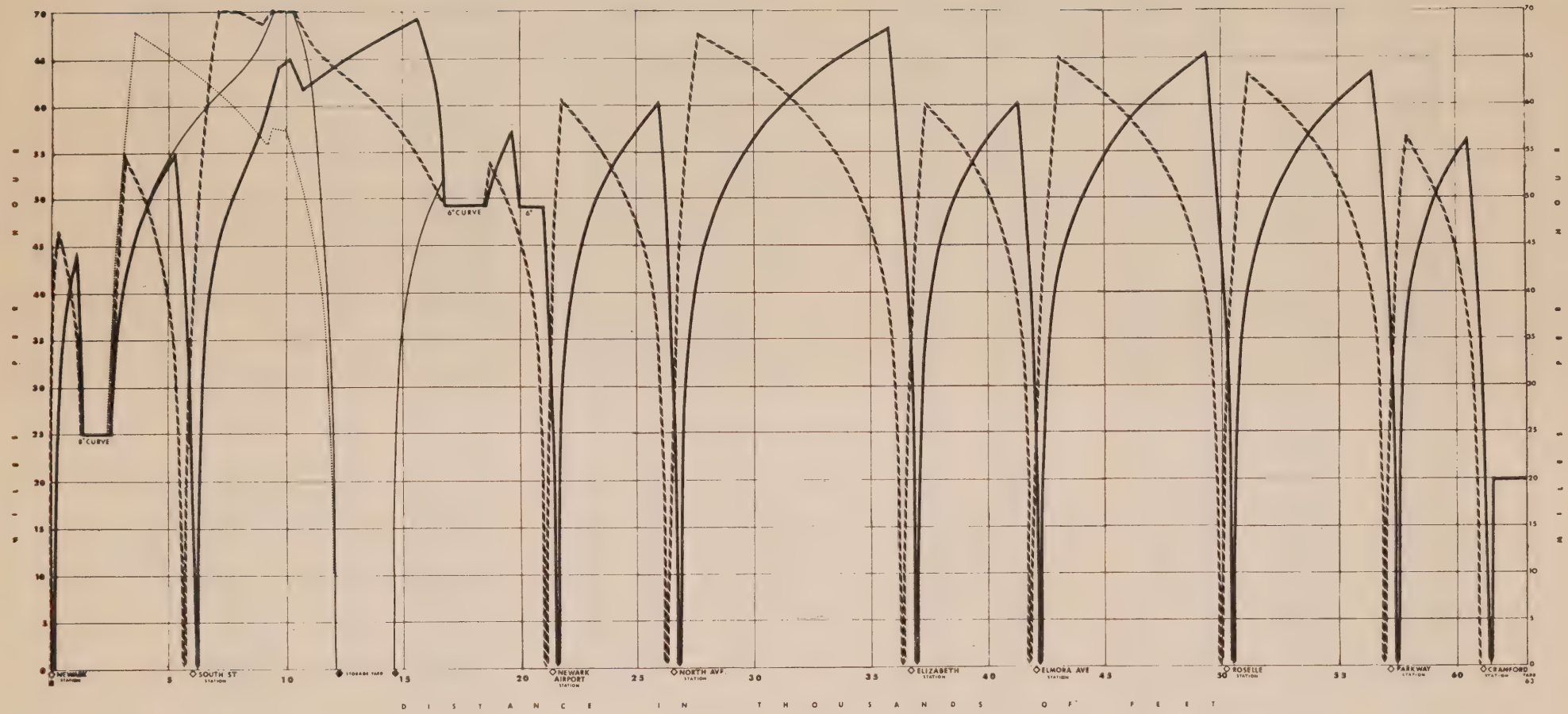
STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION
PORT OF NEW YORK AUTHORITY

EXTENSION OF PATH VIA NEWARK AIRPORT TO ELIZABETH & CRANFORD

TRACK CHART

LOUIS T. KLAUDER AND ASSOCIATES

PLATE NO. X-5C



STATE OF NEW JERSEY
DEPARTMENT OF TRANSPORTATION
PORT OF NEW YORK AUTHORITY

EXTENSION OF PATH VIA NEWARK AIRPORT TO ELIZABETH & CRANFORD

SPEED VS DISTANCE GRAPH

LOUIS T KLAUDER AND ASSOCIATES

PLATE NO. : X-6

Signal System

Design of the signal system is based on provision of a train control system of the continuous automatic speed control type, cab signals with wayside signals used only at interlocking, and for operation in both directions on each track.

We have used a service brake rate of 3 mphps with a 30% safety margin for the design. Minimum train headways will be 90 seconds between Newark and Airport stations and four minutes beyond the Airport.

PATH's existing control center is to monitor and control all train movements on the extension.

The communication system must provide radio contact to all trains and car storage yards; telephone contact to all passenger stations and car storage yards, and video monitoring of all stations.

Terminals and Service Facilities

Service turnback points require a pocket track where initially scheduled train headways are less than ten minutes. Simple crossovers are adequate where train headways are greater than ten minutes.

Storage yard capacity is designed to accept all trains originating on new segments of the system. Each yard facility is to be completely served by service train without requirement for highway access.

Vehicles

Criteria for new vehicles require the matching of all specification requirements of the latest class of PATH cars with the exception of provision for cab signals, automatic train control as well as the existing automatic train stop system, and a revised interior arrangement.

Modfications required for cars of the existing fleet which will operate on the extension must provide cab signals and automatic train stop and revision of the traction motor and control system to provide maximum acceleration rates contemplated in the initial design.

Passenger Stations

Construction to dimensions suitable for PATH cars is assumed. Modifications required for use with railroad type cars would effect platform and canopy only. Station design is based on fixed requirements of the roadway, vehicles, and service as well as requirements varying with use on location.

Fixed requirements are as follows:

Platform type	Center
Platform length	600' – to accommodate trains of 10 PATH cars or seven railroad m-u suburban type cars.
Platform width, minimum	21 feet
Platform height above top of rail	42 inches

Platform canopy length	300 feet
Platform canopy width, std.	Platform width plus two feet
Platform canopy width, major stations	Track centers plus two feet
Fare refund facility	Agent booth and toilet facility
Fare collection facility	Exact change turnstile
Turnstile capacity	20 persons per minute
Escalator capacity	1600 persons/ft. of rated width/hour

Other criteria vary with the expected volume of riders using a station; the type of station access; the station use – that is, the patron's work-end, home-end, or transfer station; and the station environment.

Facility Requirement	Variable
Platform seats	10 seats per 1000 daily riders
Cross track walkway, (Where used)	10 ft. min, width, 2 ft. additional for each 1000 riders per hour over 1000.
Parking facility, provision	Located at home-end stations only
Parking facility capacity	One car space per 1.5 round trip riders.

DESCRIPTION OF ROADWAY AND STRUCTURES

Viaduct

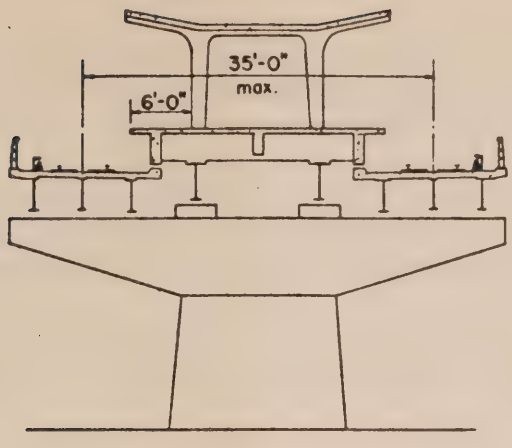
The viaduct structure used between South Street and Elizabeth traverses ground having such diverse uses and characteristics that wide variations occur in height, main girder span, and permissible depth of structure. For this reason, use of a steel girder composit concrete deck structure has been selected as most suitable.

No special soil investigations along the proposed route have been made for this study and the preliminary designs have utilized information developed for structures previously built in this area.

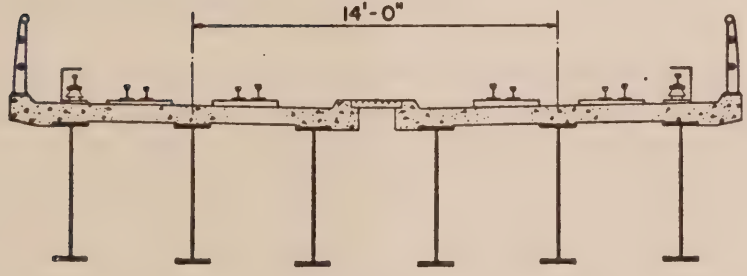
The ground beneath all sections of viaduct was initially tideland marsh which has since been filled during commercial development of the area. A wide range of fill material underlaid by combinations of sand, clay and silt, is found. The PATH viaduct, like other heavy structures in the vicinity must be supported on piles.

Cast in place concrete piles of depths anticipated between 35 and 45 feet are recommended for the PATH structure. Retaining walls in deep cut and tunnel structures will not require piles.

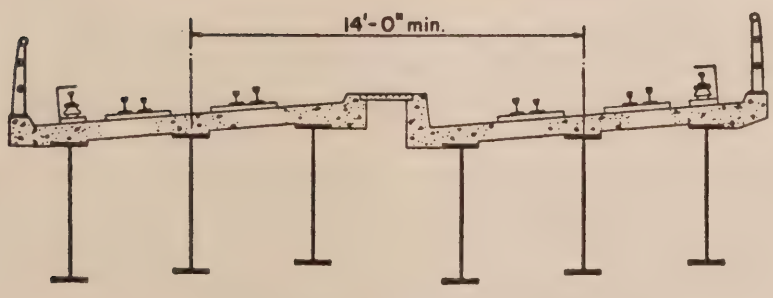
Viaduct not affected by unusual terrain or cultural features will have single pedestal piers with monolithic concrete pier caps supporting main girder spans of approximately 100 feet. Girders will be arranged in triplets beneath each track to provide a minumum depth of structure. The girders will have a constant depth across the span of approximately 65 inches.



SECTION AT STATION



SECTION ON TANGENT



SECTION ON CURVE

AMMANN & WHITNEY CONSULTING ENGINEERS 111 EIGHTH AVENUE, NEW YORK 11, N.Y.	PATH EXTENSION TO NEWARK AIRPORT	SK. NO.
	TYPICAL VIADUCT SECTIONS	P71-1
DATE Sept. 30 1971		

PLATE X-7

We suggest consideration of the use of self-protecting steel in viaduct structures to avoid requirement for painting.

Aesthetic considerations for viaduct structures dictate emphasis on unbroken surfaces on concrete and steel members, including exclusion of exposed splice plates, outside girder stiffeners, concealed ducts and conduit for traction power and signal cables, and exposed track structure.

Two cast-in-place reinforced concrete decks, each of 14 ft. width and with a thickness of 9 inches will be used. The deck structures will carry a 3 ft. wide steel walkway between. A lightweight metal side railing will be used to provide for the safety of maintenance personnel.

Where station platforms and canopies are to be carried by viaduct structure, two steel girders of approximately 42 inch depth will support platform cross girders of reinforced concrete.

Roadbed At-Grade

Segments of roadbed at grade are required along the western edge of Penn Central's Waverly Yard and between CNJ's Elizabeth Yard and Cranford.

The latter will use the existing railroad roadbed improved by a major grade crossing separation, repaired drainage structures, and cleaned drainage ditches.

PATH roadbed along Penn Central right-of-way will be designed with drainage ditches on each side. The ditches will have 2:1 slopes and ditch bottom width of 18 inches. Concrete trough ditches will be used where required by width restrictions. These drainage features will be connected by cross track culverts and planned to work within the existing pattern of Waverly Yard drainage system.

All at-grade sections of PATH will be isolated by heavy duty woven wire fence 6 ft. high. Where 13'–6" PATH to CNJ track centers occur, the fence is prohibited for clearance reasons. In this case fence will be built along the CNJ south right-of-way line to isolate both the railroad and PATH.

Track Structure

Track structure on viaduct will consist of 132 pound per yard continuous welded rail affixed directly to grout pads in the concrete deck by means of spring clips and resilient pads. All viaduct trackage will be equipped with guard rail consisting of 100 pound jointed rail clipped to the deck.

Turnout and crossover frogs and switches on viaduct structure will be attached to conventional switch timbers which in turn would be attached to steel channels imbedded in the concrete deck. All at-grade track construction will consist of conventional ballasted track using 8'–6" timber ties and continuous welded rail. Fixation of rails to timber ties will use rubber pads between rail base and tie plate to minimize noise, improve ride qualities, and lengthen the track maintenance cycle. We suggest that a change be considered in the event that the price differential between timber ties and precast concrete ties favors the latter at the time of final design.

Yard track will consist of 100 pound rail on timber ties. Yard lead tracks will utilize welded rail affixed by conventional tie plates and anchors.

All turnouts and crossovers on viaduct locations will be equipped with guarded switch rail. Railroad type equipment will be used at all at-grade locations.

ELECTRIC TRACTION POWER SYSTEM

The traction power system will use substations spaced at a nominal interval of two miles and located to use available land having close proximity to adequate sources of Public Service Electric and Gas Company's power transmission facilities. Our substation spacing calculations assume a 25% voltage drop resulting from use of a bimetallic 117 pound section, ACCR contact rail and 132 pound running rails.

We have based the size of substations on the contemplated peak schedule and utilization of the longest specified trains operating in the most demanding manner, that is, two trains starting at each station (and where appropriate, at the nearby car storage yards).

Substation capacity, location and type is as follows:

Substation	No. 1 8,000 KVA, station 95+00, outdoor
	No. 2 5,000 KVA, station 200+00, outdoor
	No. 3 3,000 KVA, station 272+00, outdoor
	No. 4 3,000 KVA, station 371+00, indoor
	No. 5 3,000 KVA, station 460+00, outdoor
	No. 6 6,500 KVA, station 568+00, outdoor

The westernmost substation on the existing PATH system will, upon completion, be Dock Substation just east of Newark station. This will replace the old South Street substation.

The extension's No. 1 substation will be located on property now owned by Penn Central Railroad located at the western end of Highway Route 21 viaduct. The power source will be PSE&G's 26 KV line along the Lehigh Valley.

Substation No. 2 will be located on Port Authority property adjacent to the viaduct where it passes the new Newark Airport breaker stations. New switching components in the breaker station will be required to serve the PATH substation.

Substation No. 3 will be located along the south side of Dowd Avenue on the site of an industrial building which must be demolished to make way for viaduct construction. It will be supplied by a 2500 foot aerial extension of PSE&G's 26 KV York Street line and the 13 KV Dowd Avenue line.

Substation No. 4 will be located in an enclosed structure beneath PATH tracks and on the west side of Union Street in Elizabeth. A new abutment wing wall and a retaining wall will both enclose two sides of the substation and provide for the roadway just west of Elizabeth station. The substation power source will probably be new circuits which are now required to reinforce the 26 KV underground lines along Union Street.

Substation No. 5 will be located in an open lot on the south side of CNJ right-of-way and west of Linden Road. This will be on property purchased also to permit street widening as part of the Linden Road grade separation. The substation power supply will be from a 26 KV trackside aerial line connecting to a PSE&G source.

Substation No. 6 will be located adjacent to the Garden State Parkway and PATH's parking area on the inbound side. The substation power source will be the existing aerial line extending westward on South Avenue from the nearby PSE&G substation.

Substations, No. 2 and No. 6 are sufficiently close to existing PSE&G substations that sole-use lines can be provided.

Substations will be equipped with oil filled air cooled transformers feeding to six phase silicon diode rectifiers. All substations will be unattended. Monitoring and control will be from PATH's central power control center.

The third rail on all road segments and storage tracks will have remote controlled power actuated isolating switches.

SIGNAL AND COMMUNICATION SYSTEMS

The system beyond Newark will be provided with an automatic train control system of the coded continuous automatic speed control type with provision for a four indication cab signal with overspeed protection at three speeds. These speeds are tentatively 10, 27 and 48 miles per hour. No maximum speed limit is considered since the cars are self limiting under all civil conditions. The speed limit command received by the train is dependent on the proximity to trains ahead, the speed over interlocked routes such as turnouts and crossovers, and the presence of curve restrictions.

Audio frequency track circuits are proposed for all sections other than at interlockings since insulated joints are not required with this system to establish block boundaries. The full capacity of both rails may therefore be used for negative propulsion return. Wayside signals are not required with the ASC system except at interlockings.

This system will permit 90 second headways between Newark Station and the turnback south of the Airport Station and 150 second headways beyond. The latter is a closer headway than actually required but comes about because it is desirable from the standpoint of track circuit design to limit their length to a maximum of 2000 feet.

Interlockings will be of conventional design with all switches power-operated and interlocked with the signals at interlocking limits and the ASC system. Remote control of all interlocked switches and signals will be provided from the PATH Control Center at Journal Square, with local control also provided for maintenance, testing and special conditions. Indications will be transmitted to the Control Center to show the location of trains for monitoring purposes and include certain malfunction alarms. The additional train display board will require alterations to equipment and structure at the Control Center.

Traffic locking will be provided on each track between interlockings to permit train operation in either direction on either track so that maintenance work can be done without interference in off-peak hours and emergency situations isolated without requiring complete cessation of service.

Communications will be provided by a two-way straight-line transmission, train-to-wayside radio system. It will have twin-lead transmission antenna cable running parallel to the track in the tunnel sections at South Newark and Cranford.

The central console will be located at the Journal Square with wayside equipment, consisting of 14 permanently mounted mobile transmitter-receivers situated at all stations, the yards at Newark and Cranford, and four intermediate points for maintenance use.

All cab equipped cars will be provided with an antenna and a mobile transmitter-receiver in the motorman's cab.

Emergency phones for passenger assistance will be provided at each station and will be separate from the aforementioned system. It will consist of direct call telephone equipment hooked up to existing telephone lines.

STATIONS AND PARKING

The fare structure and manner of refunding portions of fares (see Section XI) will require that each PATH station beyond Newark be equipped with a teller's booth at exit locations. The assignment of station tellers during all hours of train operation will require employee toilet facilities although no other station functions will require full-time assignment of personnel.

Stations will be equipped with public toilets only where demanded by a high level of use.

We have selected island type platforms for use at all stations for reasons of economy, appearance, standardization of train operations and because side platforms cannot be used in confined sections of track at South Street and along the CNJ. Access to platforms will be varied according to location of track with respect to adjacent streets and anticipated volumes of riders.

No station parking will be provided at South Street, the Airport or North Avenue stations. The Airport station will, however, be located at one of the several terminal parking lots.

Station layout and detail drawings may be found in Appendix B.

South Street Station

This station will be centered between South Street and Murray Street. It will have an island platform with a canopy. Its location on a viaduct adjacent to Penn Central's retained fill embankment permits access from only the McCarter Highway side. We propose that traffic and pedestrian control signals be improved so that a pedestrian tunnel beneath McCarter Highway is unnecessary. The expected patronage of South Street station will not justify a pedestrian tunnel, which would cost at least $150,000.

The platform will be reached by stairways from sidewalks along the east side of McCarter Highway. Location of the teller's booth and turnstiles will be at platform level.

Airport Station

The Airport Station platform will be fully enclosed for its entire platform length. The enclosed platform is proposed for the Airport station because of its expected heavy usage, and in an effort to provide the same level of comfort and attractiveness as is found in the other areas of the airport.

Access to the PATH platform from the Intra Terminal Transit System (ITT) platform directly below will be provided by two escalators with adjacent stairways. The concourse will be extended considerably further than the length of ITT platforms which is only 150 feet. The ITT platforms in turn will be reached from the ground level by escalators. The turnstiles and gating area will be located on the PATH platform.

We have not attempted to set the configuration of ITT station elements further than suggesting vertical and horizontal location of tracks and the loading location.

North Avenue Station

North Avenue station will be reached from the sidewalk area of a new median strip to be constructed along Dowd Avenue. The viaduct location will require spreading of the present two lane highway and reconstructing it as a four lane road. Stairways alone will be provided because expected patronage will not justify escalators. All turnstile and gating facilities will be at platform level.

Elizabeth Station

Elizabeth station will be located at the site of CNJ's westbound platform and station building. These will be demolished and a station access lobby constructed beneath track level directly adjacent to Union Street. The lobby will have access through the Union Street bridge abutment and from the north side parking lot. It will contain turnstiles and the teller's booth. The existing pedestrian tunnel will be completely refurbished to provide access to parking on the south side of the railroad as well as to the adjacent Penn Central station and the central business district. The abandoned pedestrian tunnel to the east can be refurbished and reopened in the event that future need requires. The railroad station and platform on the south side will remain in place for use by the CNJ's shuttle service from Jersey City, which will terminate at Elizabeth when the PATH extension is placed in operation.

Parking space for 650 cars will be located in a revised and expanded railroad lot and on new facilities to be located on adjacent properties now privately owned.

Elmora Avenue Station

Elmora Avenue Station will be located at grade on the west side of Elmora Avenue adjacent to the parking area now used by a restaurant and a drive-in coffee shop. This station will be generally similar to Elizabeth station with access from the north side of the railroad. Access to the station will be by stairs from the sidewalks along the Elmora Avenue underpass.

The existing private parking space adjacent to the station will be purchased and altered to provide space for 130 cars.

Roselle Park Station

Rosell Park station will be built at the site of the present railroad station and will reuse, in refurbished condition, the existing pedestrian underpass. The platform entrance will be from a lobby beneath track level. Parking for 400 cars will be provided on land presently owned by the CNJ on the south side of the railroad and by the purchase of private commercial properties on both sides of the railroad.

Garden State Parkway Station

The Garden State Parkway Station has been located in an effort to obtain satisfactory access from the interchange of the Garden State Parkway and North Avenue. The station complex will require removal of industrial buildings along North Avenue in order to provide access and parking space. Additional parking space for riders arriving on local streets from the south side of the railroad will be provided on property now belonging to the Staten Island Rapid Transit Railway. Total parking capacity will be 1200 cars.

Entrance to the north side parking lot from the Garden State Parkway interchange would require installation of traffic control systems to prevent traffic clogging. The State of New Jersey is now planning a widening of Garden State Parkway which will include revisions of the North Avenue interchange which presumably would be designed to improve access to PATH's parking lots.

Two 25 foot wide pedestrian concourse will connect the two parking lots and provide access to the station lobby located directly beneath the tracks.

Cranford Station

Cranford station will utilize the existing CNJ westbound island platform. This platform will be refurbished, provided with an improved canopy and platform facilities and receive improved stairway access from the existing under-track pedestrian tunnel. The eastbound island platform will be removed and a new platform built in the center of the roadway. Access to this will be provided by new stairways from the existing tunnel.

The pedestrian tunnel and its entrances will be refurbished. The existing railroad station building on the inbound side will remain to provide a waiting room and access from the parking lot.

This arrangement will permit direct cross platform transfers from PATH to CNJ commuter trains, but all gating must be located on the platforms and the station must be manned by two tellers, one for each platform.

Cranford station's present parking facilities will be altered and expanded to provide close-in space for 345 cars. Additional space will be available in the more distant municipal lots.

TERMINALS AND SERVICING FACILITIES

We considered car storage yard locations near Waverly Yard, the Dowd Avenue–Elizabethport industrial area, and Cranford. Inadequate space, high land values, and the difficulty of ramping from viaduct to ground level removed the Dowd Avenue site from detailed consideration.

Location of a storage yard in the Waverly Yard area requires purchase of industrial land between Route 21 and Noble Street. We propose a double ended yard consisting of 1650 foot long lead track and 4 ladder tracks which would provide a total capacity of 114 PATH cars, or if as stored as trains, eleven 10-car trains, two 8-car trains and space for two spares.

Train operations at the Airport station will be facilitated by a long tail track arranged to permit either of two stored trains to depart first. It is not intended for long term storage or servicing.

The Cranford Yard would consist of four storage tracks reached directly from the main tracks. It would be equipped with a tail track at the west end to provide an escape route from all tracks in case of equipment breakdown on any single track. Yard capacity would be 140 cars, and in the case of made-up trains, 12 ten-car trains, one eight-car train, and six spare cars.

In accordance with PATH's operating methods, neither yard will be equipped with access for highway vehicles and would require work trains to remove debris and trash from nightly car sweepings.

SECTION XI

PROPOSED PATH SERVICES

CRITERIA

The criteria for PATH operations on the extension were established to take maximum advantage of the PATH car operating characteristics and to provide a level of service to the Airport and the suburban stations equal or superior to alternative modes. Elements of design and operations contributing to the level of service include travel time, headways, waiting time, comfort, convenience, safety and cost.

Running times scheduled for the extension are based on the maximum design speed (70 mph), acceleration rate (2.5 mphps) and deceleration rate (3.0 mphps) of the PATH PA–1 and 2 cars. The route alignment and signal system have been selected to avoid speed restrictions wherever possible. Operating characteristics of the existing PATH system have been incorporated into the study without analysis, including the restrictive speed limits in tunnels and on at-grade sections of the line.

The criteria for determining schedule headways were to subject most airport users to an average wait no greater than 5 minutes and to provide commuter service equivalent to current peak hour schedules plus significant improvement to present off-peak service on Penn Central and CNJ.

For the comfort and convenience of Airport riders, the new cars to be purchased will have transverse seats instead of the current combination of transverse and longitudinal seating and space for a small amount of hand luggage. These changes to car interiors will also increase the comfort of the long distance commuters on the extension. Improvement to the ride quality and noise level of the new cars should also be considered.

PROPOSED TRAIN OPERATIONS

Estimated running times on the extension were prepared utilizing the LTK&A transit program with the motor characteristics of the PATH equipment and the Westinghouse K1460 traction motor. The results of the computer calculations are shown in Tables XI–1 and XI–2. Running times on the existing PATH system are shown in Table XI–3 and correspond to those now attainable with the PATH trains operating in a restricted power setting. The scheduled running times for the extension allow for restricted operation during inclement weather and makeup time for slight schedule disturbances. Representative scheduled times are:

Newark – Airport	7 minutes
Newark – Elizabeth	12 minutes
Newark – Cranford	22 minutes

TABLE XI-1

TRAVEL TIMES FOR PA-1 CAR
UNDER IDEAL CONDITIONS

Acceleration available from starting point at 1 MPH is 2.51 MPHPS

Deceleration available from starting point at 1 MPH is 3.01 MPHPS

STATION	STATION CENTERLINE LOCATION	ACCUMULATED TIME Minutes	RUNNING TIME Minutes	MAXIMUM SPEED MPH	AVERAGE SPEED MPH
Newark Penn Station	0+00	0	-	-	-
South Street	60+00	1.55	1.55	54.66	38.02
Newark Airport	213+30	5.57	3.40	69.04	51.47
North Avenue	265+75	7.67	1.49	55.21	39.61
Elizabeth	369+95	10.70	2.41	70.00	50.45
Elmora	419+61	12.75	1.43	58.70	39.68
Roselle	501+13	15.35	1.99	64.73	45.90
Parkway	571+30	17.79	1.82	63.19	44.28
Cranford	610+84	19.65	1.24	56.08	37.02

Average Scheduled Speed is 35.1 MPH

TABLE XI-2

TRAVEL TIMES FOR PA-1 CAR
UNDER ICE & SNOW CONDITIONS

Acceleration available from starting point at 1 MPH is 1.18 MPHPS

Deceleration available from starting point at 1 MPH is 1.27 MPHPS

Station	Station Centerline Location	Accumulated Time Minutes	Running Time Minutes	Maximum Speed MPH	Average Speed MPH
Newark Penn Station	0+00	0	-	-	-
South Street	60+00	1.84	1.84	53.89	32.08
Newark Airport	213+30	6.10	3.76	68.87	46.49
North Avenue	265+75	8.46	1.86	53.94	31.73
Elizabeth	369+95	11.81	2.85	69.10	42.65
Elmora	419+61	14.13	1.81	54.91	31.27
Roselle	501+13	17.03	2.40	62.04	37.99
Parkway	571+30	19.76	2.23	60.21	36.19
Cranford	610+84	21.87	2.23	51.76	28.53
Average Scheduled Speed	33.3 MPH				

TABLE XI-3

Travel Times On Existing PATH System
(Including Station Dwell Times)

Station	Travel Times (Min.) Peak-Hour	Off-Peak
Newark		
	2.36	2.36
Harrison		
	7.25	7.25
Journal Square		
	3.67	3.03
Grove-Henderson		
	2.60	2.56
Exchange Place		
	3.62	3.30
WTC		
Total	19.50	18.50
Journal Square		
	3.65	3.03
Grove		
	3.82	3.33
Pavonia		
	7.26	6.87
Christopher		
	1.42	1.18
9th Street		
	1.30	1.22
14th Street		
	1.30	1.20
23rd Street		
	1.25	1.17
33rd Street		
Total	20.00	18.00

The scheduled headways on the existing operation were used as the background for scheduling trains on the extension. Excellent service can be offered by providing 6 minute headways for trains from the Airport to the World Trade Center during the peak hours and ten minute headways during off peak hours. Stations west of the Airport between North Avenue and Cranford will be provided with 12 minute headways during the peak hours and 20 minute headways off peak.

OPERATING SCHEDULES

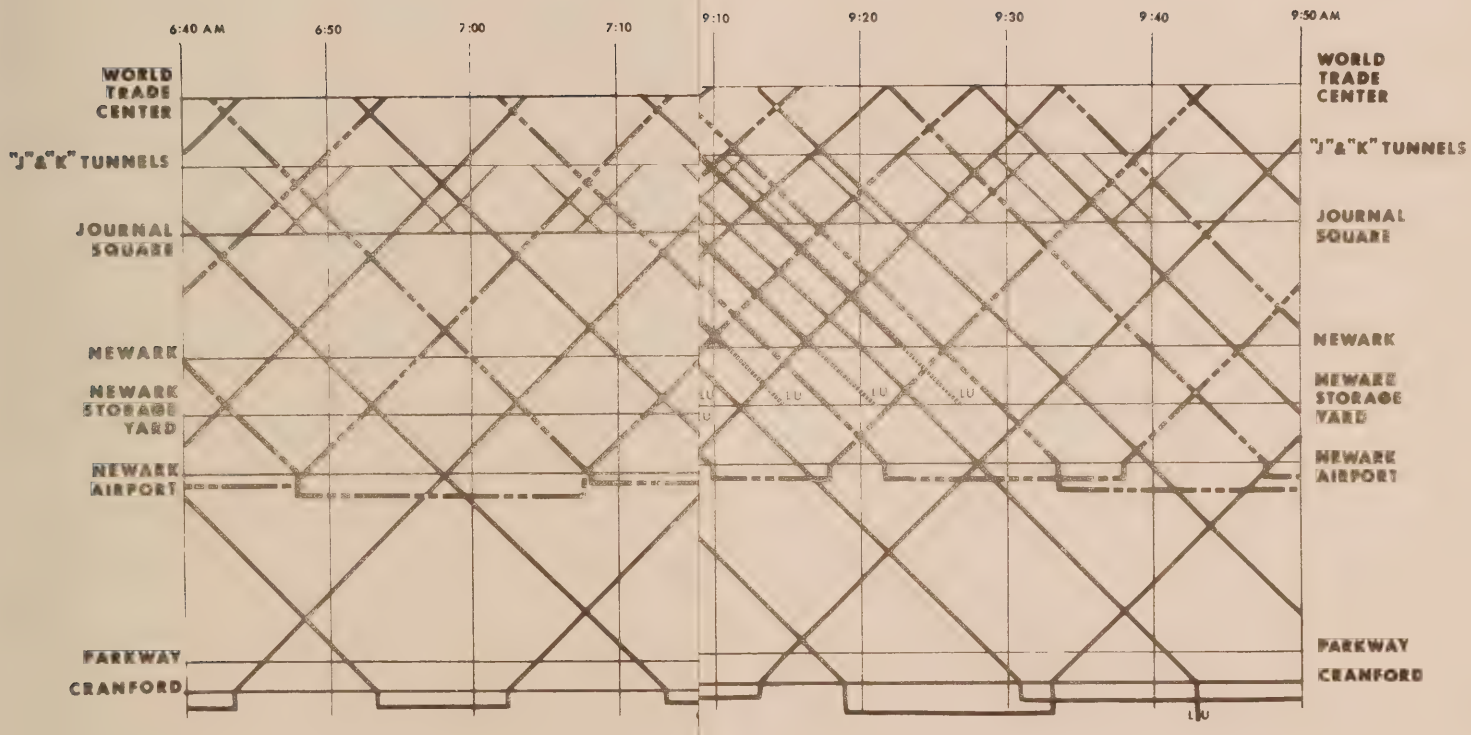
Figures XI–A and XI–B are string charts indicating the A.M. peak period train movements necessary to provide the service scheduled in Table VIII–1 (a, b & c).

Fleet size requirements are listed in Table XI–4 for both the basic and alternative expanded service. The additional cars required for the basic schedule include only those needed to increase the number of 10 car trains to provide service on the extension plus 10% spares. The expanded service would require 22 additional cars, representing 5 additional 4–car trains to 33rd Street plus 10% spares. It is assumed that PATH will increase their Newark–WTC train capacity to 10 cars with or without the extension.

The crew requirements have not been determined, as run-cutting and crew assignments affect operations on the entire system.

FARES AND FARE COLLECTION

The fare level and structure for the entire PATH system will be as shown in Table XI–5; the collection method is outlined in Table XI–6. This fare system accomplishes the Port Authority objectives of retaining a cash fare collection method and avoiding a necessity to replace existing equipment.



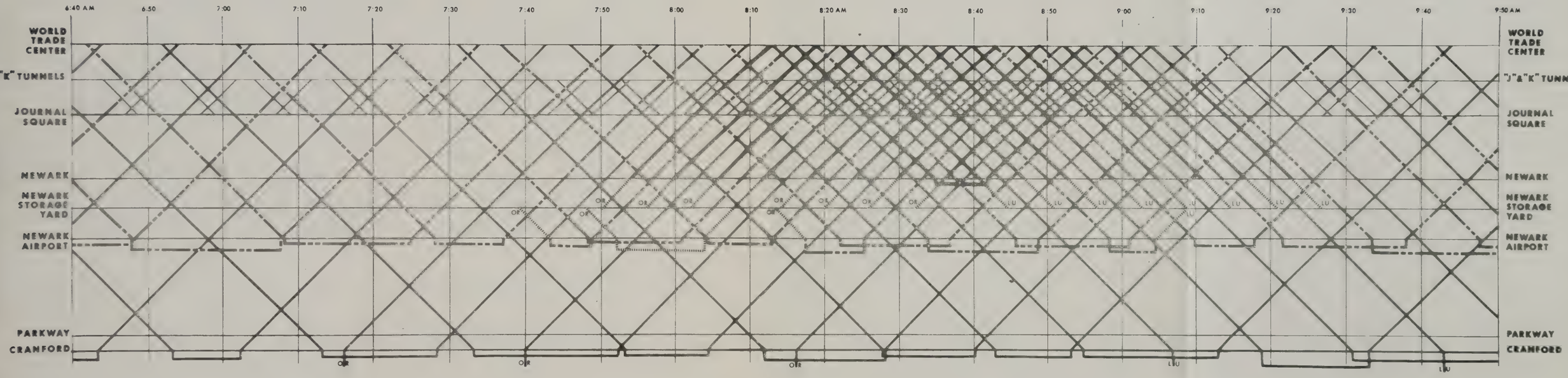
STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION
PORT OF NEW YORK AUTHORITY

EXTENSION OF PATH VIA NEWARK AIRPORT TO ELIZABETH & CRANFORD

LOUIS T. KLAUDER AND ASSOCIATES

STRING CHART – ALTERNATIVE 1

FIGURE XI–A



LEGEND

CRANFORD / WORLD TRADE CENTER

NEWARK AIRPORT / W.T.C.

NEWARK / W.T.C.

JOURNAL SQUARE / 33rd STREET

NONREVENUE

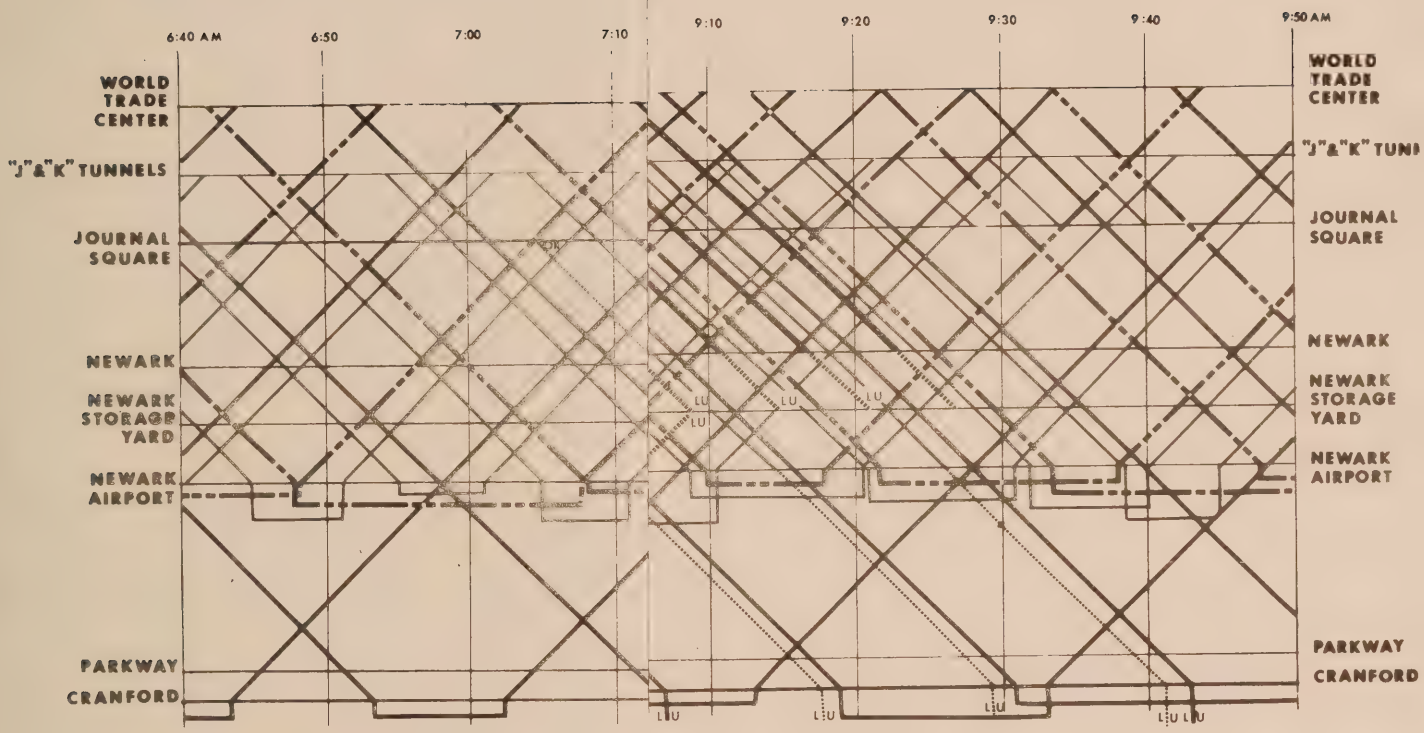
STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION
PORT OF NEW YORK AUTHORITY

EXTENSION OF PATH VIA NEWARK AIRPORT TO ELIZABETH & CRANFORD

LOUIS T. KLAUDER AND ASSOCIATES

STRING CHART – ALTERNATIVE 1

FIGURE XI–A



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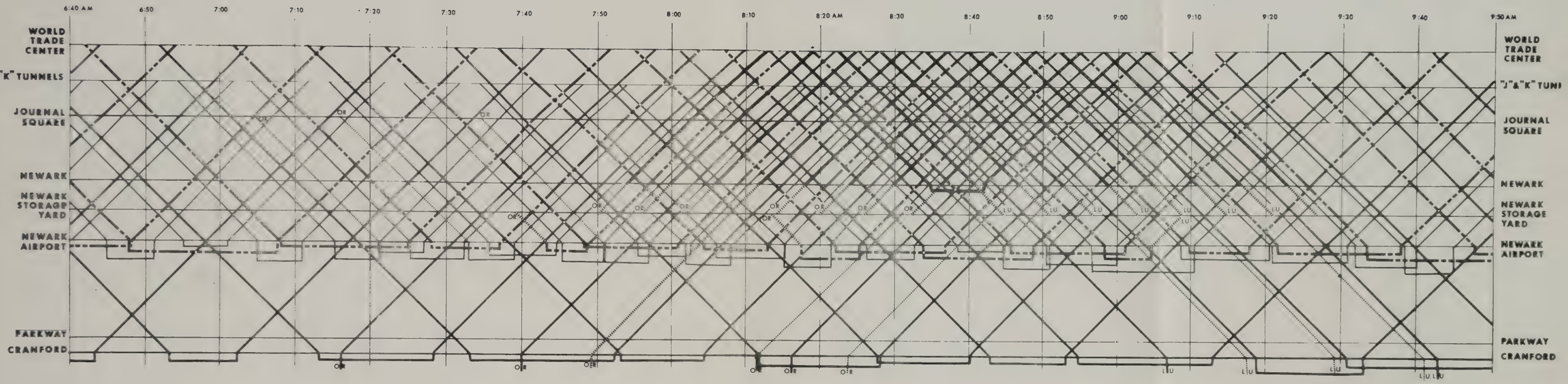
EXTENSION OF PATH VIA NEWARK AIRPORT TO ELIZABETH & CRANFORD

LOUIS T. KLAUDER AND ASSOCIATES

STRING CHART – ALTERNATIVE 2

FIGURE XI- B



LEGEND

CRANFORD / WORLD TRADE CENTER

NEWARK AIRPORT / W.T.C.

NEWARK / W.T.C.

JOURNAL SQUARE / 33rd STREET

NONREVENUE

STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION
PORT OF NEW YORK AUTHORITY

EXTENSION OF PATH VIA NEWARK AIRPORT TO ELIZABETH & CRANFORD

LOUIS T. KLAUDER AND ASSOCIATES

STRING CHART – ALTERNATIVE 2

FIGURE XI- B

PATH FLEET REQUIREMENTS

CONSISTS WTC Line 33rd Street Line	Future PATH w/out Extension 10 cars/train 4 cars/train	Basic Service 10 cars/train 4 cars/train	Expanded Service 10 cars/train 4 cars/train
Trains Required:			
Newark-WTC	16 (160 cars)*	8 (80 cars)	8 (80 cars)
Airport-WTC	-	6 (60 cars)	6 (60 cars)
Cranford-WTC	-	8 (80 cars)	8 (80 cars)
J.S. - 33rd St.	9 (36 cars)	9 (36 cars)	-
Airport-33rd St.	-	-	14 (56 cars)
Sub-total	25 (196 cars)	31 (256 cars)	36 (276 cars)
10% spares	20 cars	25 cars	27 cars
Total Cars	216 cars	(281 cars)	303 cars
Additional cars required	0	65 cars	87 cars

*Includes train to arrive at WTC at 8:55 a.m.

TABLE XI-5

FARE STRUCTURE AND LEVEL

ZONES		I	II	III	IV
I	Jersey City & New York City	.30	.30	.60	.90
II	Newark		.30	.60	.60
III	Airport				.60
IV	Elizabeth to Cranford				.30

Stations in Zones

I. All New York stations, Journal Square, Grove, Exchange Place, and Pavonia

II. Harrison, Newark and South Street

III. Newark Airport

IV. North Ave., Elizabeth, Elmora Ave., Roselle, Garden State Parkway and Cranford.

Note: Intrazone fares are $.30 for all zones.

TABLE XI-6

Proposed PATH Fare Collection Method

	Coin Fare in Gates	EXIT STATION ZONES			
		I	II	III	IV
Entrance Station Zones	OUT / IN	None	None	.30	.60
I All stations East of Harrison	.30	Free	Free	Pay .30	Pay .60
II Harrison, Newark South Street	.30	Free	Free	Pay .30	Pay .30 w/coupon
III Newark Airport	.60	Free	Free	---	Free with coupon
IV North Ave. & West (6 stations)	.90	Free	Refund .30 w/coupon	Refund .30 w/coupon	Refund .60 w/coupon
Pay-out Gates		No	No	Yes	Yes
No. Attendants		None	3	1	6

SECTION XII

CHANGES TO EXISTING FACILITIES

Few highway and utility changes will be required because the PATH roadway will generally be carried on viaduct or placed on existing railroad right-of-way. However considerable alteration of PCRR catenary support structures and CNJ trackage is required.

This section deals with the changes required to all effected facilities except existing facilities of PATH.

RAILROADS

Penn Central Railroad

Construction of the PATH viaduct will require abandonment of Penn Central's South Street station which is now served by eight trains daily. The outbound side will be isolated from street access, and the platform area must be lowered by several feet in order to provide clearance for viaduct bents. Modifications must be made to the cap of the retaining wall at several points south of this station.

The electrified siding tracks providing access to S. Broad Street yard adjacent to the Route 21 viaduct ramp will be isolated from Penn Central track but could be connected to adjacent Lehigh Valley RR sidings. Portions of this trackage are now used for storage of Penn Central track and electrical maintenance cars, but there is space available for these cars on the east side of the main tracks.

The heavily used Lehigh Valley to Penn Central passenger connection must be by-passed with a temporary track during construction of the PATH underpass. The existing track will then be restored to its present configuration.

Between East Peddie and Van Duyne Streets all sidings and industrial leads on the western side of the Penn Central R.R. must be abandoned and removed. The most active delivery track, that near Van Duyne Street, can remain but will be realigned westward onto newly purchased right-of-way to permit construction of the PATH viaduct ramp between it and the main tracks.

Six catenary support structures must be reguyed between South Street and Route 21, and 43 catenary structures must be replaced or altered between Hunter Tower and Haynes Avenue.

Construction of the PATH viaduct across Waverly Yard requires that a section of track No. 0 be cut-out and replaced by lengthening of an adjacent stub track. In this area catenary readjustments are required on No. 1 track (jumpover track) so that the messenger wire can be attached to the viaduct girders.

PATH enters CNJ property near Elizabethport freight house, which has active rail sidings. In order to avoid abandonment of those sidings, PATH will go over the freight house. Limits to viaduct girder spans will require that pier footings be placed beneath the freight house. This will require short term closing of small portions of the buildings and will slightly reduce interior space where permanent viaduct piers rise through the buildings.

No track changes are required along Elizabethport Yard ladder and storage tracks.

PATH use of CNJ main line tracks No. 2 and No. 4 will require major reconstruction between Elizabethport and Garwood. The railroad does not now require four tracks and generally restricts main line trains to No. 1 and No. 2 track. CNJ management does not agree to the use of single track supplemented by passing sidings.

Conversion of the present four track railroad to a double track system, using tracks No. 1 and No. 3 for the east and westbound mains can be achieved by rebuilding track No. 3.

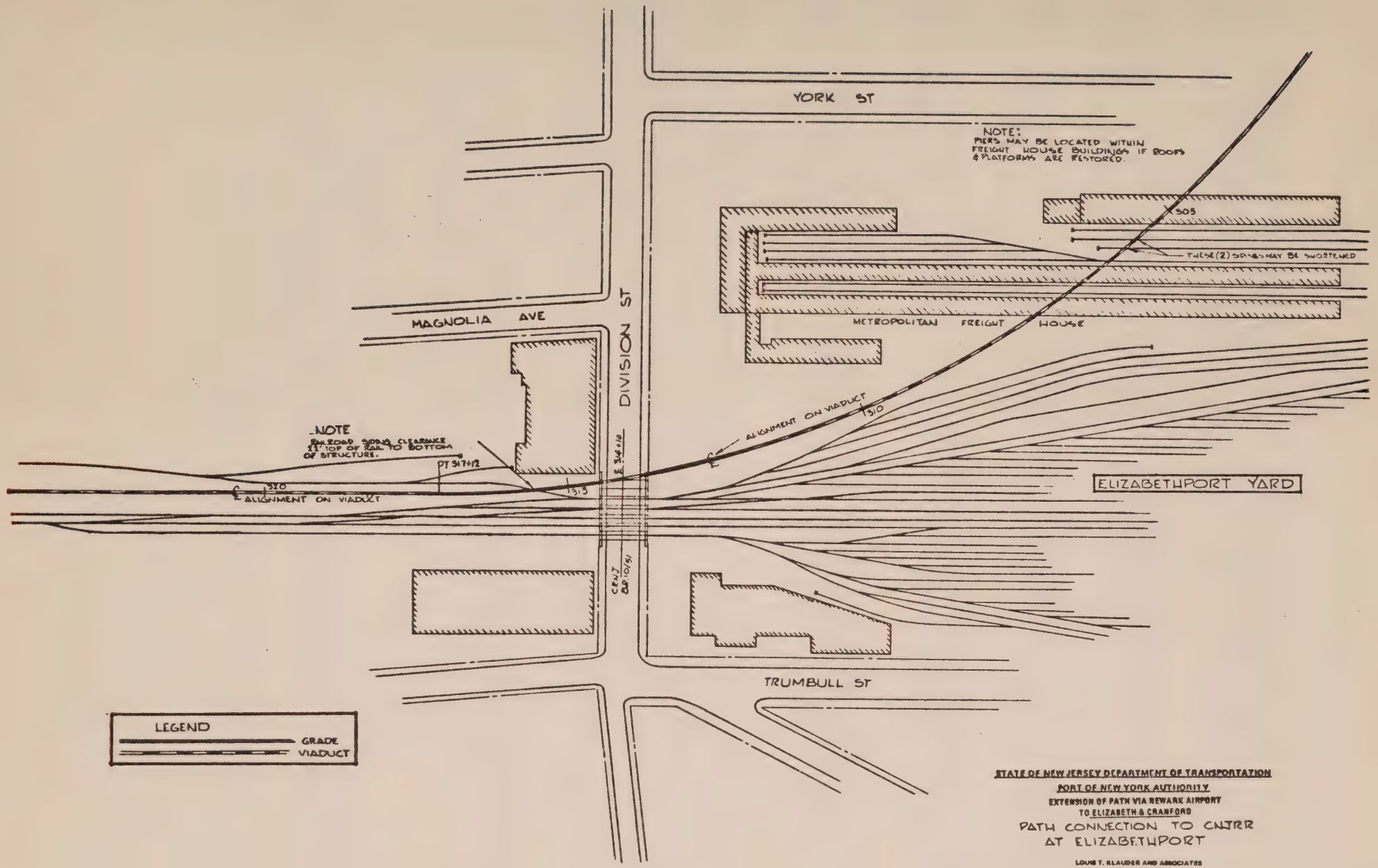
Track No. 2 has been lowered to accept high loads at points of overhead restriction such as Penn Central's overhead crossing in Elizabeth. Track No. 1 must therefore be lowered in a similar manner by revising Broad Street bridge and the station pedestrian tunnels and by undercutting ballast. Ballast undercutting is also required to lower track No. 3 at Cherry and Chilton Street overhead bridges.

West-end access to Elizabethport Yard must be altered by interlocking changes at Division Street (see Plate XII–B).

Complicated changes are required at Aldene where freight car classification and train make-up are necessary for interchanges to the Staten Island Rapid Transit Railway (B&O) and the Rahway Valley Railroad. The complexity is increased by the necessity to retain both the commuter train connection to the Lehigh Valley Railroad and various sidings to industrial leads at Aldene. The entire CNJ Aldene yard must be removed to provide space for PATH tracks and the Parkway Station.

Sufficient area now exists in the adjacent SIRT yard to convert this to a double-ended yard and relocate the SIRT – CNJ junction track. Since the new yard will have to be used for classification of Rahway Valley trains, a track is necessary to connect this yard with tracks on the north side of the roadway. This connecting track must cross PATH alignment (PATH will be depressed). The connecting track will also carry eastbound commuter traffic and perhaps, in the future, through freight traffic between CNJ and the Lehigh Valley. CNJ management wants the design to permit a second future connecting track to provide for the latter possibility.

A track for westbound commuter trains will continue along the roadway's north edge to Cranford to make possible cross platform transfers with terminating westbound PATH trains.



STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION
PORT OF NEW YORK AUTHORITY
EXTENSION OF PATH VIA NEWARK AIRPORT
TO ELIZABETH & CRANFORD
PATH CONNECTION TO CNJRR
AT ELIZABETHPORT
LOUIS T. KLAUDER AND ASSOCIATES
PLATE NO. XII - A

This track must be paralleled for some distance with a make-up siding on the north side. (For use by Rahway Valley trains.) Hence portions of the CNJ right-of-way must be widened by 12 feet between Elizabeth Avenue and Centennial Avenue. Unbuilt portions of residential property will be affected by this widening, and XC tower will be removed.

Plate XII–B shows that the two main tracks will pass through Cranford station at the roadway's south edge. This requires demolition of the existing eastbound island platform and construction of a new platform toward the center of the roadway.

The PATH storage yard will extend from Cranford west beyond Lincoln Avenue to Garwood. Here new interlocking will be required to return CNJ tracks to the present configuration of four main tracks plus two outer industrial lead access tracks.

The new interlockings at Division Street in Elizabethport, Aldene, and Garwood will be fully automatic and remote controlled from Elizabethport. All tracks will be signaled for operation of trains in both directions.

The changes described will provide CNJ with upgraded main tracks, a modern and fully automatic remote controlled signal system, and electrically operated switches throughout the affected area. Very few active industrial sidings will be affected, and railroad operations and maintenance will be improved by the changes.

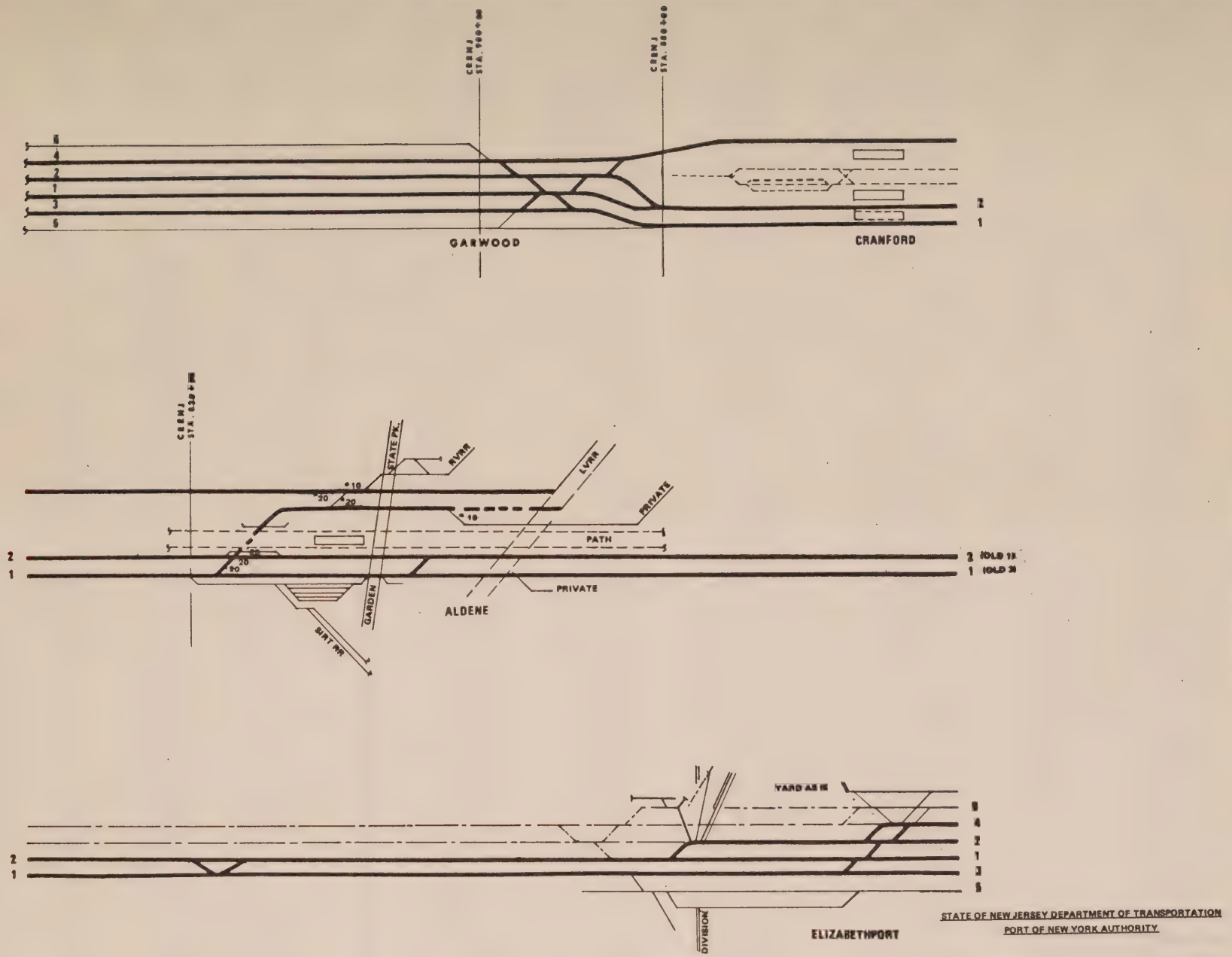
When the Linden Road grade separation is constructed for PATH it will be neither desirable nor physically practical to retain the railroad grade crossing. We have considered a design and construction sequence which would place both the railroad and PATH tracks nine feet above the present railroad elevation at Linden Road and would lower the street pavement by eleven feet. The railroad now passes Linden Road on a 0.51% grade westbound, and CNJ management does not want any grade over 0.60%. This grade requires a 1.3 mile long earthfill embankment, starting east of Grove Street and requiring replacement of the Grove Street and Elmora Avenue bridges with new, slightly elevated structures. Our estimates of cost of construction include this grade separation.

It should be noted that replacement of Elmora Avenue bridge will be required for other reasons than the highway grade separation. The station approach will cause PATH track centers to widen at the bridge, requiring at the very least a new single track span. Further, the highway overhead clearance at this underpass is an inadequate 12'–6".

Staten Island Rapid Transit Railway

The preceding description of yard and junction changes includes mention of the SIRT yard. This yard is now little used and affords rental space for contractor stone cutting operations. A SIRT property purchase or easement is essential.

Track changes to the SIRT – CNJ connection will require revisions to SIRT signal facilities.



STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION
PORT OF NEW YORK AUTHORITY

EXTENSION OF PATH VIA NEWARK AIRPORT
TO ELIZABETH & CRANFORD

REVISIONS TO CENTRAL RAILROAD OF NEW JERSEY
ELIZABETHPORT TO GARWOOD

LOUIS T. KLAUDER AND ASSOCIATES

PLATE NO. XII-8

HIGHWAY CHANGES

No permanent changes to the pavements or major structures of streets and highways will be required between South Street and Route US 1–9. Temporary pavement openings and minor permanent changes to street light and street signal structures will be required along McCarter Highway.

Construction of viaduct piers in the medial strip of Route 1–9 (in its proposed new alignment) and the airport entrance interchange will require slight modification of medials and construction of safety barriers.

Construction of the proposed interchange between Route 1–9 and new Route 81 may precede PATH construction. This interchange will extend northwesterly along Dowd Avenue from Division Street. We have reviewed preliminary interchange plans prepared by the New Jersey Department of Transportation and find that two of the considered alternatives can be sufficiently modified to accept piers of the PATH viaduct.

Dowd Avenue must be modified to a four lane divided street for a distance of 1,800 feet southeast from Division Street. Widening of right-of-way on the southwest side is possible with no removal or alteration of adjacent industrial buildings. New traffic control signals will be provided for Dowd Avenue intersections at North Avenue, Division Street, Progress Street and one adjacent industrial street.

The remaining section of the PATH line to Cranford will require changes to certain highway crossings now existing along the CNJ. Union Street, Grove Street, and Elmora Avenue in Elizabeth will receive new railroad and transit bridges, and Linden Road will be grade separated as described previously.

Revisions to the Garden State Parkway – North Avenue interchange will probably be required to improve access to the new station parking space. On advice from New Jersey Department of Transportation, we have not evaluated this need or its solution, because planned widening of the Parkway will require revision of the present interchange.

Other station parking facilities will not require changes to the configuration of adjacent streets.

ELECTRIC AND GAS UTILITY FACILITIES

Electric power and gas transmission and distribution facilities of Public Service Electric and Gas Company will be affected as follows:

Three poles of the 26 KV double circuit aerial power line which parallels Lehigh Valley Railroad tracks will be altered to provide space for the retained cut south of the PATH underpass of the Lehigh Valley – Penn Central connection in Newark.

The Waverly tie feeder which crosses beneath Penn Central tracks at Haynes Avenue can be protected from PATH track loads by a concrete cover slab.

A 26 KV aerial line along the entranceway of the Anheuser–Busch plant must be altered to a bundled conductor type and relocated to clear the PATH viaduct.

A 200 feet section of the 12 inch diameter gas line beneath a road within the Anheuser-Busch plant must be relocated to clear foundations of the viaduct.

The 138 KV pipe-type underground power transmission line beneath Dowd Avenue must be relocated for a distance of 1,000 feet west of Division Street.

The 13 KV aerial power line and low voltage distribution circuits along Dowd Avenue must be relocated for an extent of 2,500 feet. This will entail relocation of all poles and relocation of distribution transformers and cables.

The 4 KV and 26 KV aerial lines along York Street in east Elizabeth must be revised to clear the PATH viaduct.

Reconstruction of bridge abutments on Union Street in Elizabeth will require relocation of four 26 KV underground cables located along the east curb line.

Revision of railroad bridges crossing Grove Street and Elmora Avenue will require minor changes to 4 KV aerial distribution lines.

Construction of the Linden Road grade separation will require relocation of 4 KV aerial distribution lines on Linden Road and minor revision of similar lines on First Avenue and Westfield Avenue.

SEWERS AND WATER MAINS

No relocation of the storm and sanitary sewers which cross McCarter Highway will be required by viaduct construction.

The East Peddie Street storm sewer which crosses Penn Central tracks north of Waverly yard will be reconstructed to carry PATH tracks just west of the railroad.

A new surface level 72 inch diameter pipe to carry drainage from Interstate Route 78 into Peddie Ditch has been proposed by the Department of Transportation. This will closely parallel PATH tracks, which will consequently be placed on two feet of fill to reduce loads on the drain.

Temporary protection of a 96 inch storm drain and a 36 inch sanitary sewer will be required during construction of the viaduct along the plant entrance road of the Anheuser-Busch plant.

Relocation of 2500 feet of a 39 inch sanitary sewer and a 16 inch water main will be required prior to placement of viaduct on Dowd Avenue.

Revision to a storm sewer and collector drains along First Avenue at Linden Avenue in Roselle Park will be required as part of the Linden Avenue grade separation project.

SECTION XIII

ESTIMATED CAPITAL COSTS

Our estimates of the cost of construction are based on third quarter 1971 price levels and include a 20% contingency for unforseen problems which may arise during construction.

The total costs include 30% for costs of engineering, administration, legal and financial fees, insurance, interest during construction and preliminary operation.

Purchase costs for rolling stock are based on the cost of PATH's most recent car purchases including spare parts adjusted for change in interior configuration, additional signal equipment and escalation to 1971 prices.

The total costs for rolling stock include 15% for engineering, inspection acceptance testing, preliminary operation, interest during construction, insurance administration and contingency.

The cost of property acquisition was estimated by the New Jersey Department of Transportation. The costs include a 25% addition for costs of purchase.

The estimated costs provide for land; railroad, highway and utility revisions including the Linden Avenue grade crossing separation; and transit construction and equipment.

Our estimates do not include costs for the airport ITT track and station facility or for the following changes to existing PATH equipment and plant which must be altered to permit extended service.

1) Installation of ATC signal equipment on all cars which may now serve PATH's Newark line.
2) Revision of traction motor connections on these cars.
3) Building and electrical equipment revisions necessary to permit installation of signal and electric traction power control and monitoring units in PATH's Control Center.
4) Revision at Newark station to allow gated entry and exit at each platform.
5) Revision of car shop facilities to serve the expanded fleet.

The total estimated cost of $174 million is presented in detail on subsequent page.

This cost would escalate to approximately $256 million at the end of a seven year construction period.

I VIA NEWARK AIRPORT TO ELIZABETH AND CRANFORD

CONSTRUCTION – COSTS IN THOUSANDS OF DOLLARS

	Newa	VII Linden Road Grade X-ing Elim. to Garden State 1.856 Mile	VIII Garden State Pky to Cranford 1.403 Mile	Total 12.161 Mile
Route Facilities				
Property Acquisition				
Industrial		1,400	3,340	14,980
Commercial		510	750	2,755
Residential		-	50	50
Sub-total		1,910	4,140	17,785
Route Preparation				
Revision to Railways		2,755	4,945	15,915
Revision to Highways		-	-	1,950
Revision to Utilities		-	-	3,110
Sub-Total		2,755	4,945	20,975
Transit Fixed Facilities				
Roadway		395	7,595	53,830
Track		2,070	1,335	13,720
Traction Power		2,570	3,990	24,060
Signals & Comm.		870	660	6,510
Passenger Stations (1)		1,155	2,885	11,240
Station Parking and Access Roads		460	1,940	3,280
Storage Yards, Maint. Facilities and Misc.		-	730	2,265
Sub-Total		7,520	19,135	114,905
Total, Route Facilities		12,185	28,220	153,665
Rolling Stock				20,000
GRAND TOTAL				173,665

(1) Costs of platform and suppor

EXTENSION OF PATH VIA NEWARK AIRPORT TO ELIZABETH AND CRANFORD

ESTIMATED COST OF CONSTRUCTION – COSTS IN THOUSANDS OF DOLLARS

	I	II	III	IV	V	VI	VII	VIII	
	Newark Station to Lehigh Valley Duck-Under	Lehigh Valley Duck-Under	Lehigh Valley Duck-Under to Airport Sta.	Airport Sta. to CNJ Elizabeth-Port Yark	Elizabethport Yard To Linden Rd. Grade X-ing Elim.	Linden Road Grade Crossing Elimination	Linden Road Grade X-ing Elim. to Garden State	Garden State Pky to Cranford	Total
	1.553 Mile	0.455 Mile	2.159 Mile	1.591 Mile	1.610 Mile	1.534 Mile	1.856 Mile	1.403 Mile	12.161 Mile
Route Facilities									
Property Acquisition									
Industrial		905	2,605	2,885	2,220	1,625	1,400	3,340	14,980
Commercial	-	-	-	-	785	710	510	750	2,755
Residential	-	-	-	-	-	-	-	50	50
Sub-total		905	2,605	2,885	3,005	2,335	1,910	4,140	17,785
Route Preparation									
Revision to Railways	200	760	820	-	3,015	3,420	2,755	4,945	15,915
Revision to Highways	100	-	80	1,570	-	200	-	-	1,950
Revision to Utilities	-	10	155	2,895	-	50	-	-	3,110
Sub-Total	300	770	1,055	4,465	3,015	3,670	2,755	4,945	20,975
Transit Fixed Facilities									
Roadway	4,190	3,720	12,495	18,630	5,125	1,680	395	7,595	53,830
Track	930	505	2,910	2,015	2,255	1,700	2,070	1,335	13,720
Traction Power	1,430	2,975	4,595	3,055	2,860	2,585	2,570	3,990	24,060
Signals & Comm.	995	310	1,450	745	755	725	870	660	6,510
Passenger Stations (1)	985	-	2,620	1,135	1,385	1,075	1,155	2,885	11,240
Station Parking and Access Roads	-	-	-	-	740	140	460	1,940	3,280
Storage Yards, Maint. Facilities and Misc.	-	-	895	640	-	-	-	730	2,265
Sub-Total	8,530	7,510	24,965	26,220	13,120	7,905	7,520	19,135	114,905
Total, Route Facilities	8,830	9,185	28,625	33,570	19,140	13,910	12,185	28,220	153,665
Rolling Stock									20,000
GRAND TOTAL									173,665

(1) Costs of platform and supporting structure is contained in the costs for roadway facilities.

.TES, CONSULTING ENGINEERS

SECTION XIV

IMPLEMENTATION AND THE CONSTRUCTION PERIOD

DESIGN AND CONSTRUCTION PERIOD

We estimate that service between Newark Station and the Airport can commence within four to six years from the time of full project authorization. Commencement of service to Cranford appears feasible within five to seven years. These periods may be shortened or lengthened by up to a year according to progress of the necessary pre-construction public hearings. Extreme acceleration of design and construction might permit additional shortening of six months to a year.

A graphic schedule of the construction period appears on the next page.

WORK SEQUENCE

Land purchase and detailed design will commence on the section between Newark station and the Airport.

Removal of Penn Central siding tracks, relocation of catenary supports, retaining wall revision, and underpinning of Hunter Tower and Lehigh Valley RR bridge piers can be staged to permit simultaneous construction of the viaduct along McCarter Highway, the PATH underpass of the LVRR connection and the viaduct crossing of Waverly yard. Construction of viaduct on airport and highway property requires less preparation and can be the initially completed sections.

Commencement of specialty construction such as track and signals must await completion of major portions of the roadbed and viaduct structures.

Delivery of a portion of the additional car fleet should coincide with start-up of the Newark to Airport portions of signal and traction power systems.

Construction of the outer portions of the line should follow as quickly as the completion of designs permits.

After modification to CNJ track and structure for high and wide load clearances have been made at Elizabeth, the Linden Road grade crossing separation including the bridges at Grove Street and Elmora Avenue, may commence. With CNJ now operating on tracks No. 1 and No. 3, tracks No. 2 and No. 4 can be removed between Elizabeth and Roselle and the roadbed prepared for track installation. The right-of-way preparation for the PATH storage yard at Cranford can be done in conjunction with the construction of the new CNJ interlocking plant west of Cranford.

After the present interlocking plant at Cranford Junction has been removed, the PATH duck-under will be built.

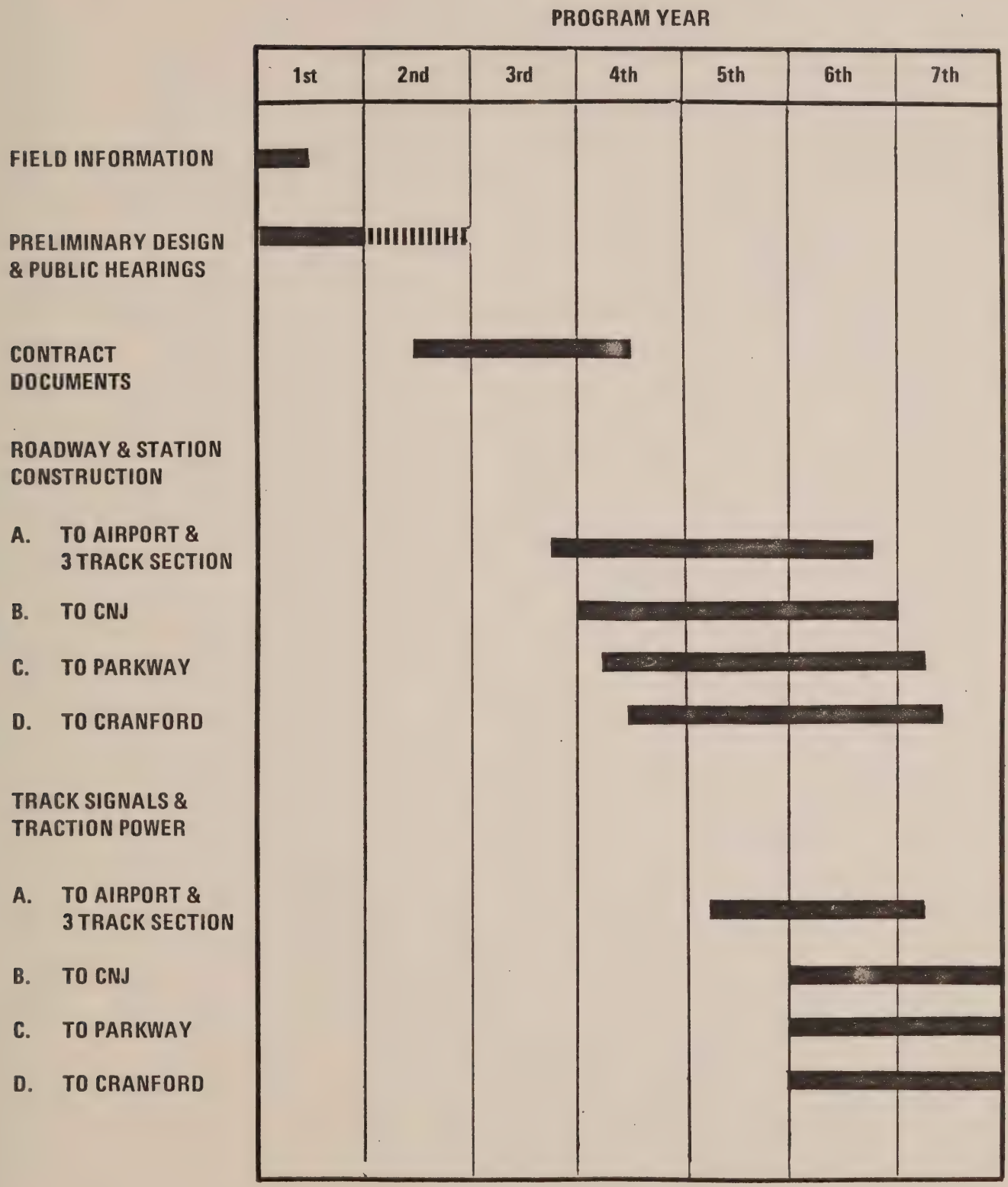
The viaduct from the Airport to the CNJ tracks with the station at North Avenue can be completed along with the roadbed to Elizabeth station after the CNJ interlocking at "GW" is relocated.

With the completion of the new railroad freight yards and new connections for the Rahway Valley and Lehigh Valley, construction of the Garden State Parkway station, as well as roadbed preparation for PATH tracks through the area may begin.

Substation construction will follow preparation of right-of-way at Elizabeth, Linden Avenue and Aldene.

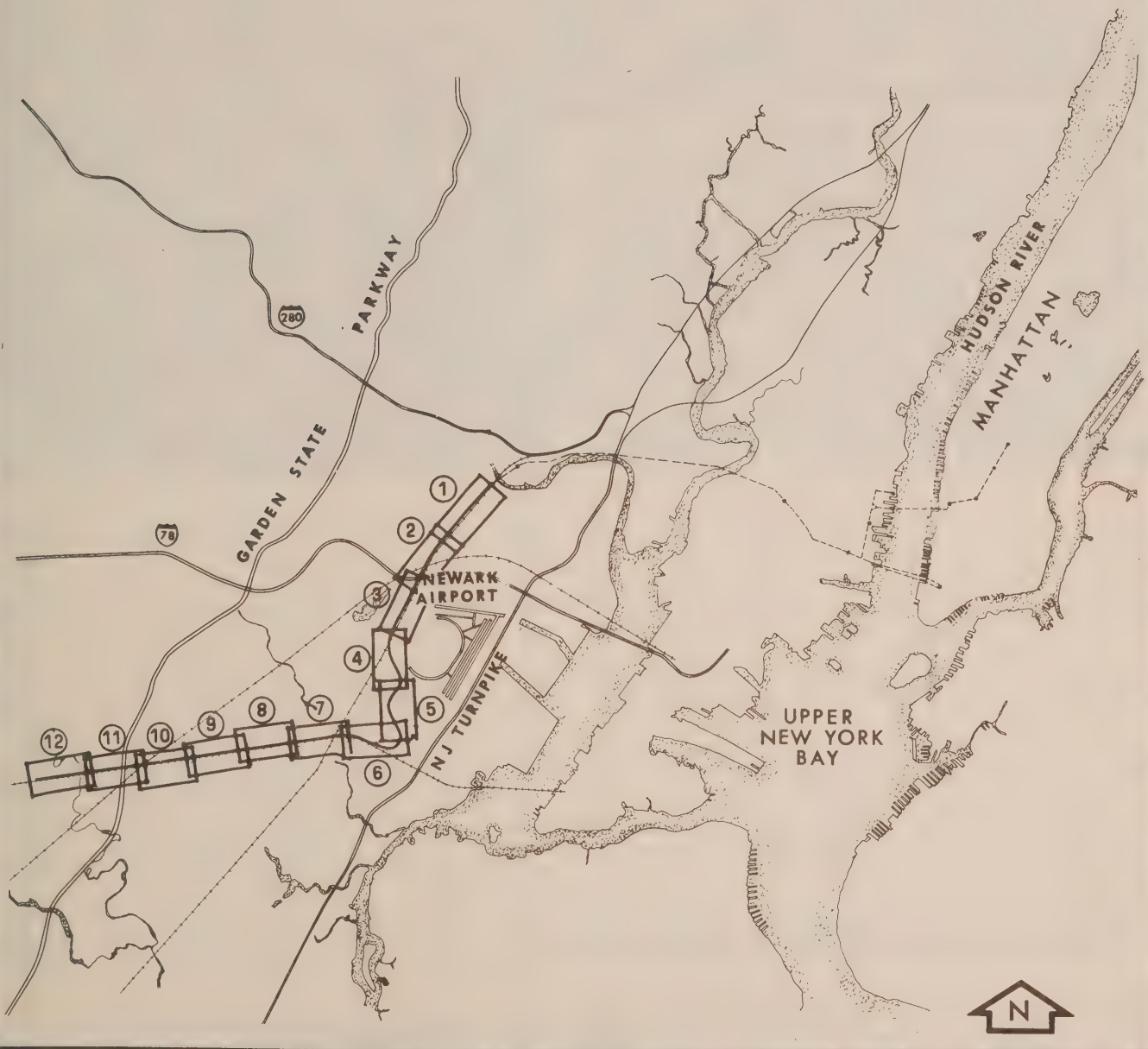
New station construction will accompany roadway and viaduct construction. Track, third rail, and signal construction will follow both.

CONSTRUCTION STAGING FOR PATH



APPENDIX A

INDEX MAP



STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION

PORT OF NEW YORK AUTHORITY

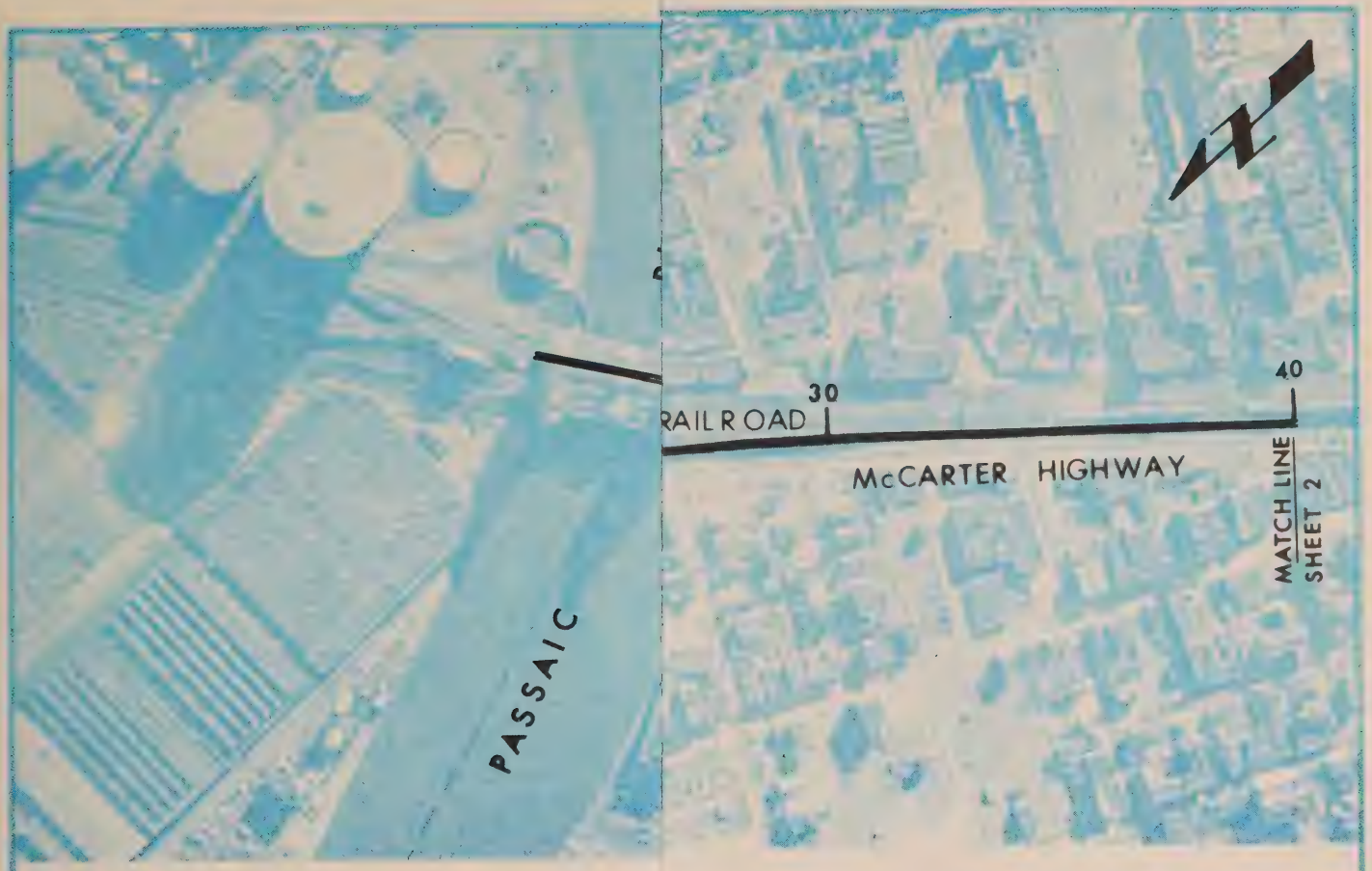
EXTENSION OF PATH

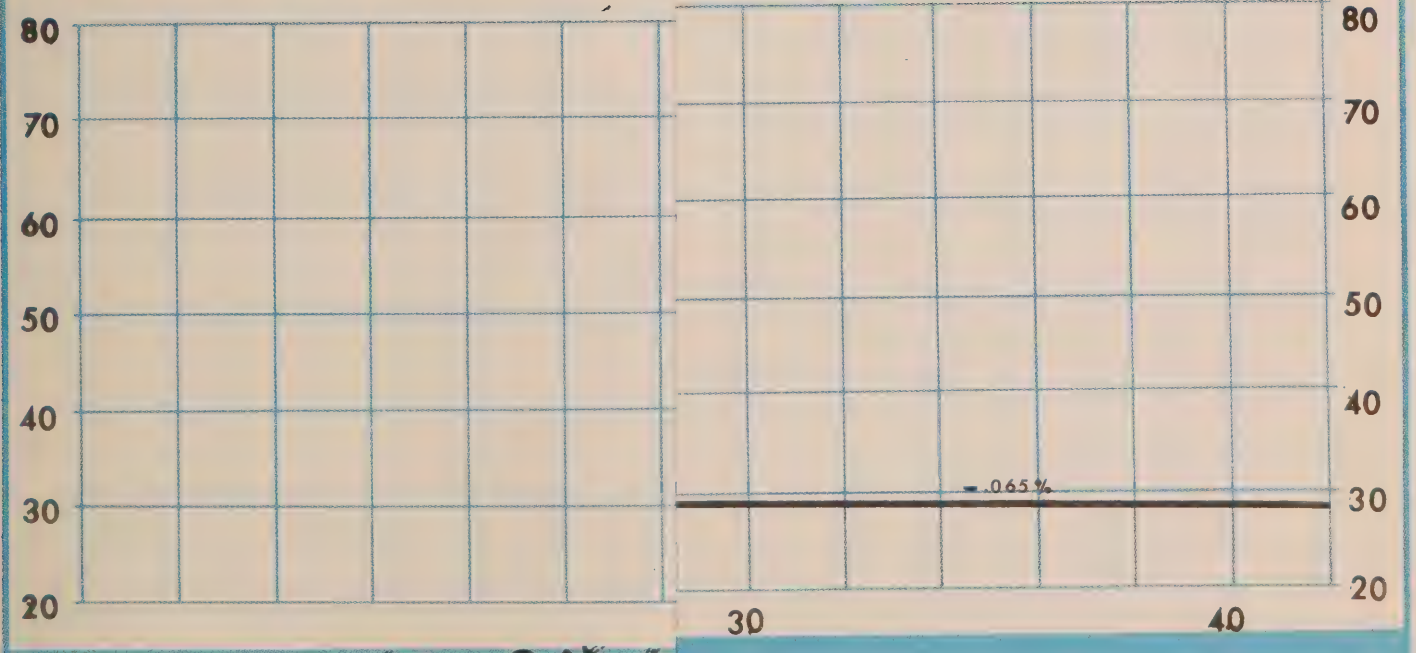
VIA NEWARK AIRPORT TO ELIZABETH

AND

WEST ON THE CENTRAL RAILROAD OF NEW JERSEY

LOUIS T. KLAUDER AND ASSOCIATES, CONSULTING ENGINEERS

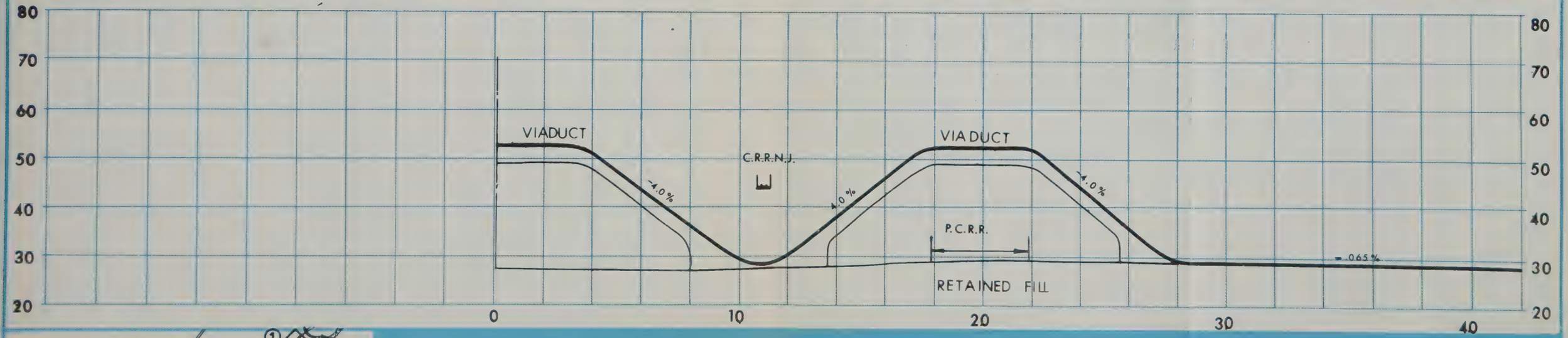


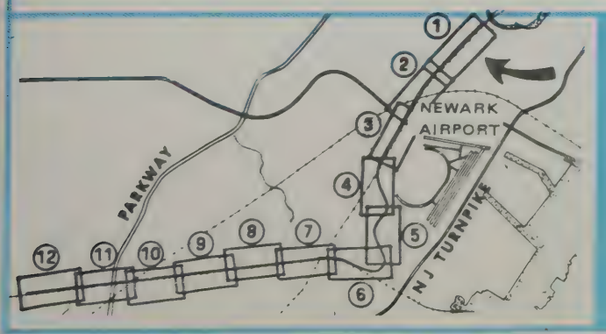


LINE SEGMENT:

NEWARK STATION TO SOUTH ST.

SHEET NO.: (1) STA. 0 TO STA. 40





STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION
PORT OF NEW YORK AUTHORITY

ENGINEERING STUDY OF AN EXTENSION OF PATH

VIA NEWARK AIRPORT TO ELIZABETH AND WEST
ON THE CENTRAL RAILROAD OF NEW JERSEY

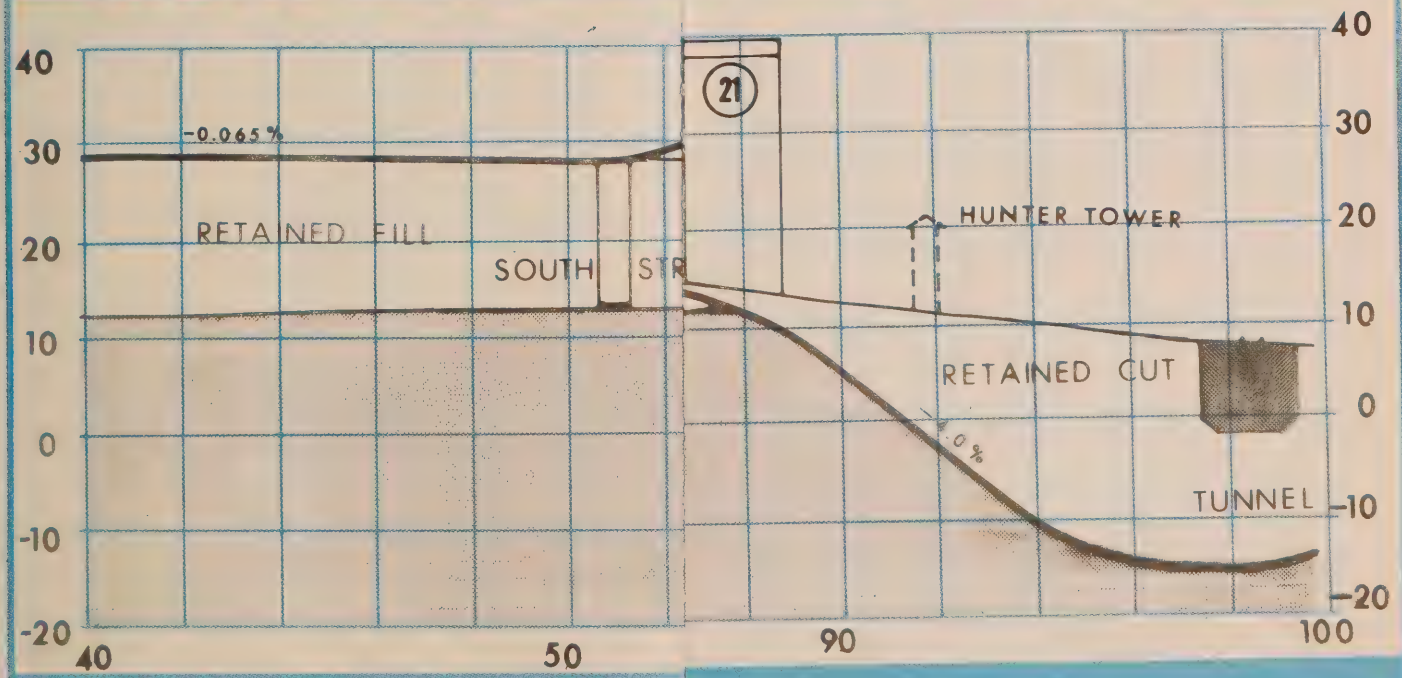
HORIZ. SCALE: 1"=400' VERT. SCALE: 1"=20'

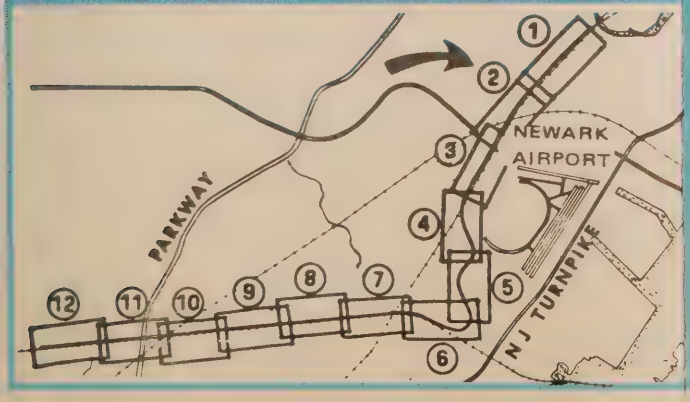
LINE SEGMENT:

NEWARK STATION TO SOUTH ST.

SHEET NO.: (1) STA. 0 TO STA. 40

LOUIS T. KLAUDER AND ASSOCIATES, CONSULTING ENGINEERS

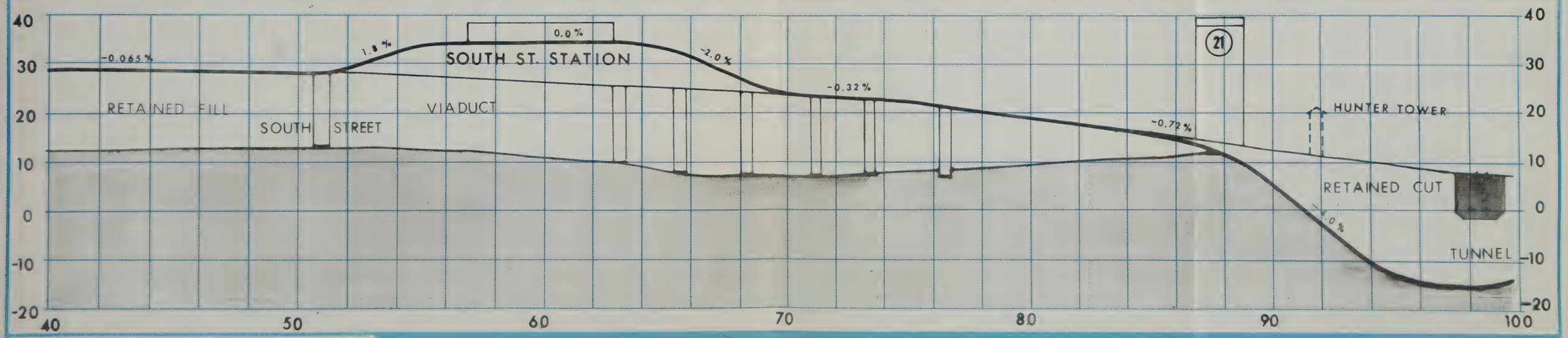




LINE SEGMENT:

SOUTH ST. TO LEHIGH VALLEY RR

SHEET NO.: (2) STA. 40 TO STA. 100



STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION
PORT OF NEW YORK AUTHORITY

ENGINEERING STUDY OF AN EXTENSION OF PATH

VIA NEWARK AIRPORT TO ELIZABETH AND WEST
ON THE CENTRAL RAILROAD OF NEW JERSEY

HORIZ. SCALE: 1"=400'

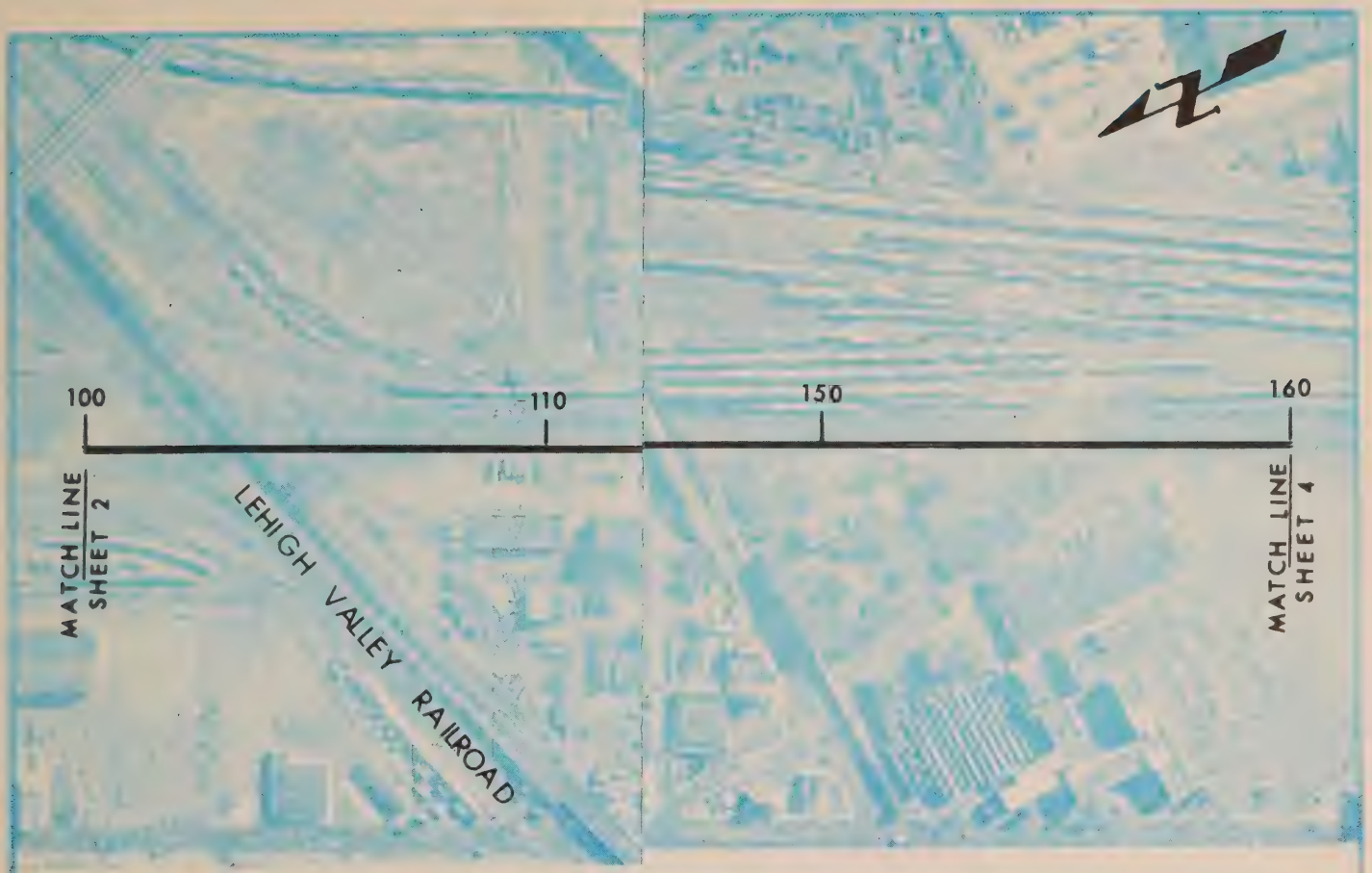
VERT. SCALE: 1"=20'

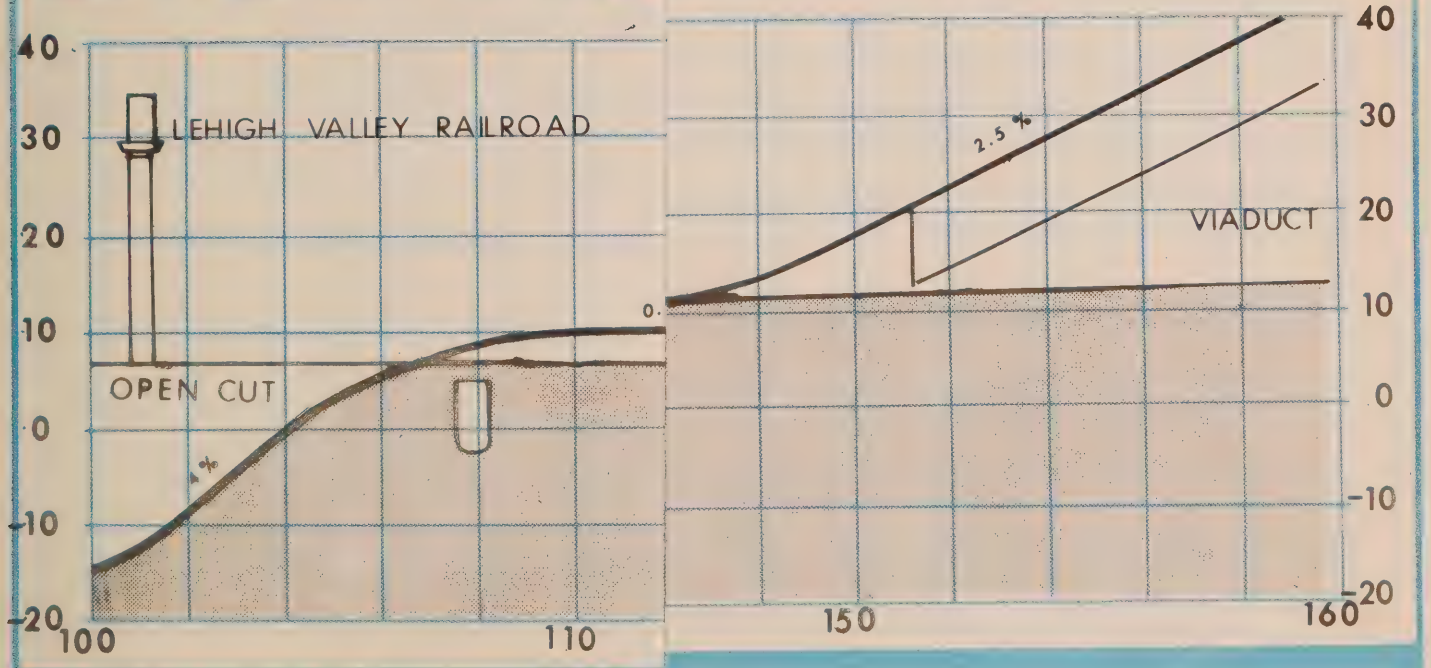
LINE SEGMENT:

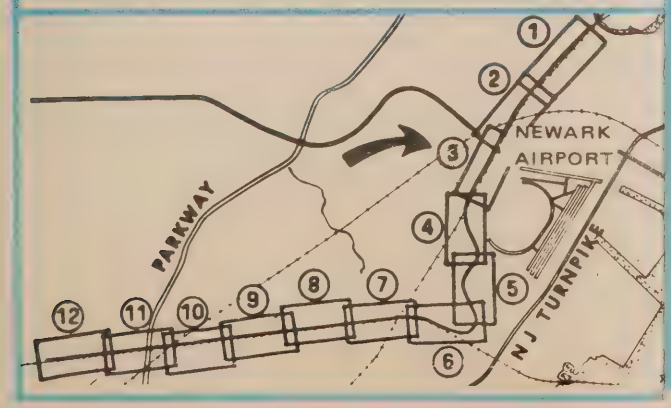
SOUTH ST. TO LEHIGH VALLEY RR

SHEET NO.: (2) STA. 40 TO STA. 100

LOUIS T. KLAUDER AND ASSOCIATES, CONSULTING ENGINEERS



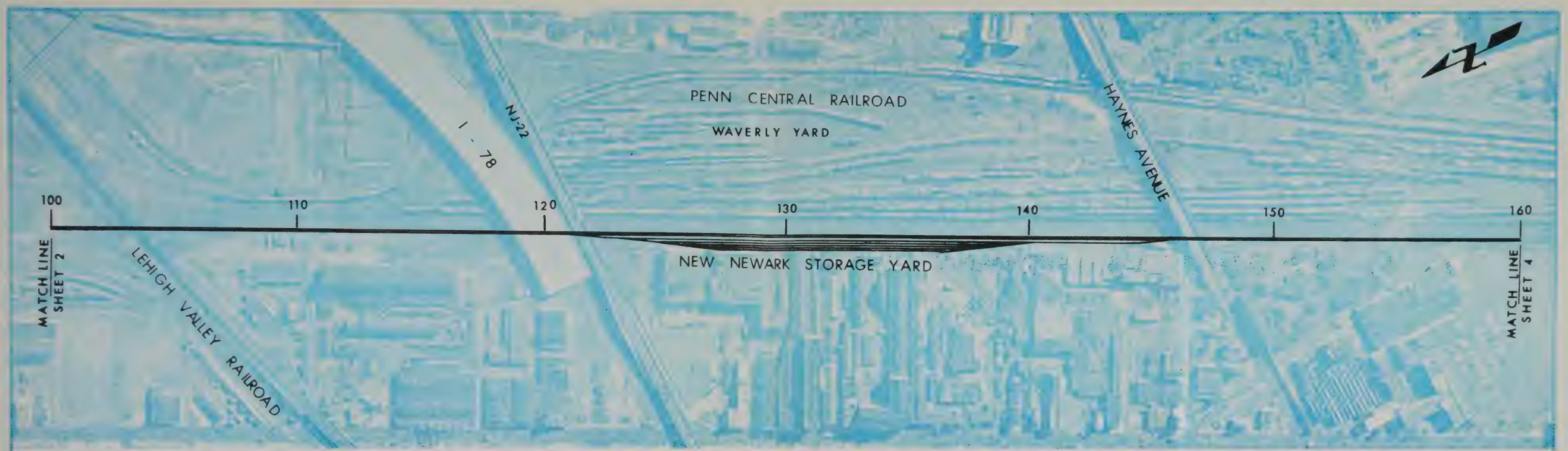


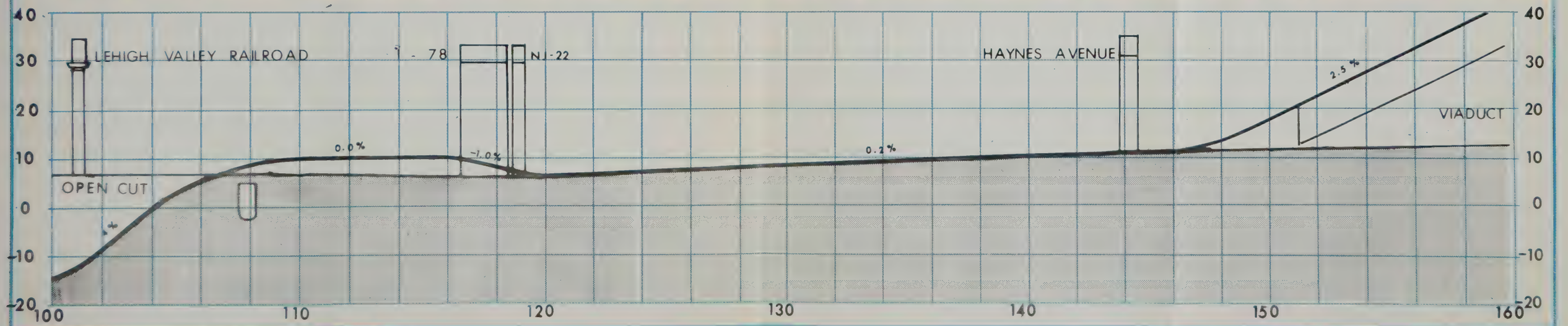


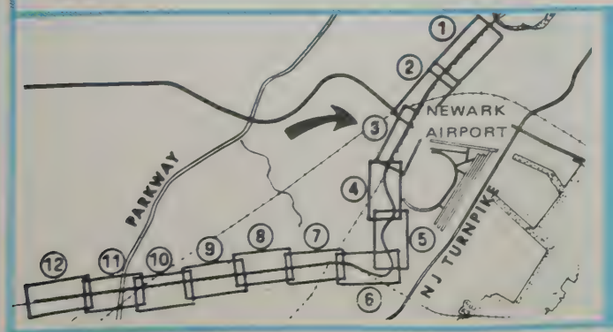
LINE SEGMENT:

LEHIGH VALLEY RR TO PENN CENTRAL CROSS-OVER

SHEET NO.: (3) STA. 100 TO STA. 160







STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION
PORT OF NEW YORK AUTHORITY

ENGINEERING STUDY OF AN EXTENSION OF PATH

VIA NEWARK AIRPORT TO ELIZABETH AND WEST
ON THE CENTRAL RAILROAD OF NEW JERSEY

HORIZ. SCALE: 1"=400'

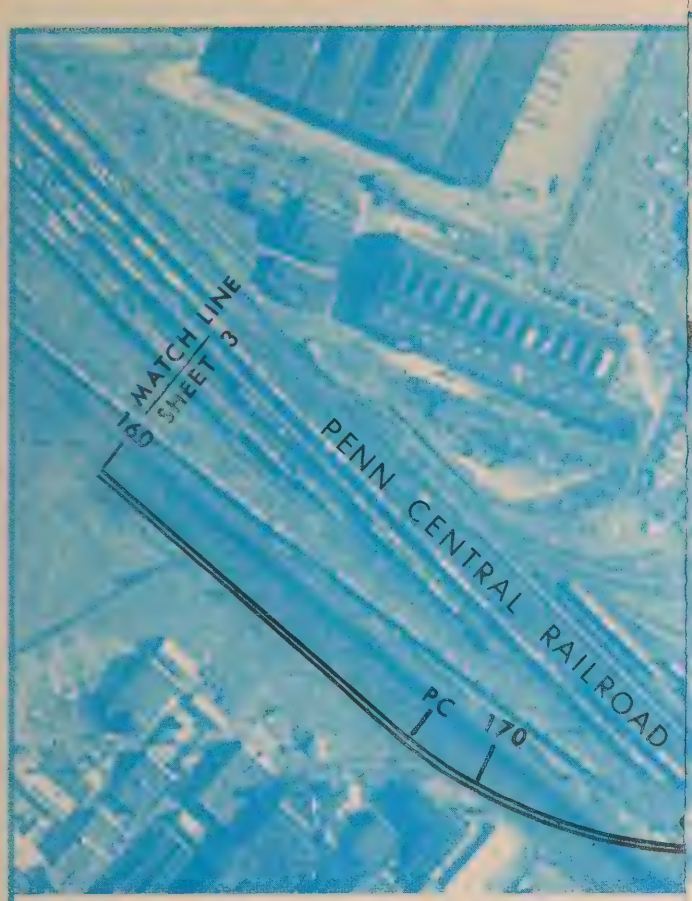
VERT. SCALE: 1"=20'

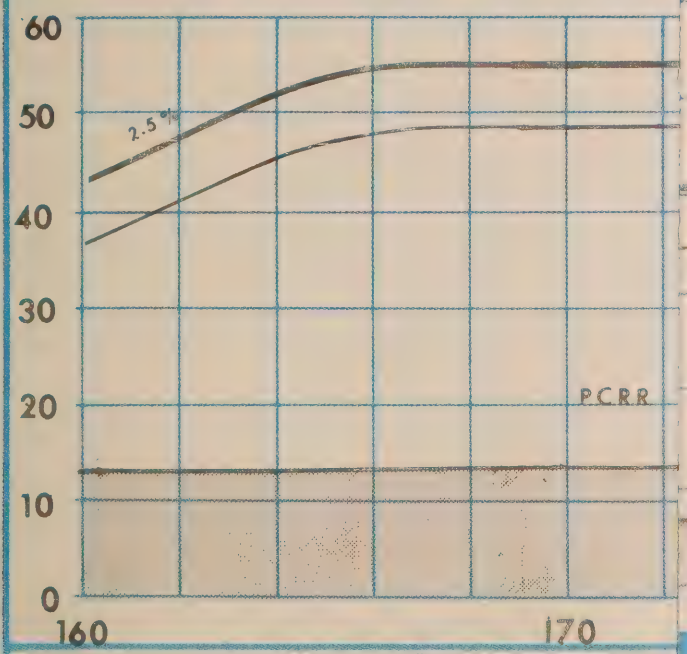
LINE SEGMENT:

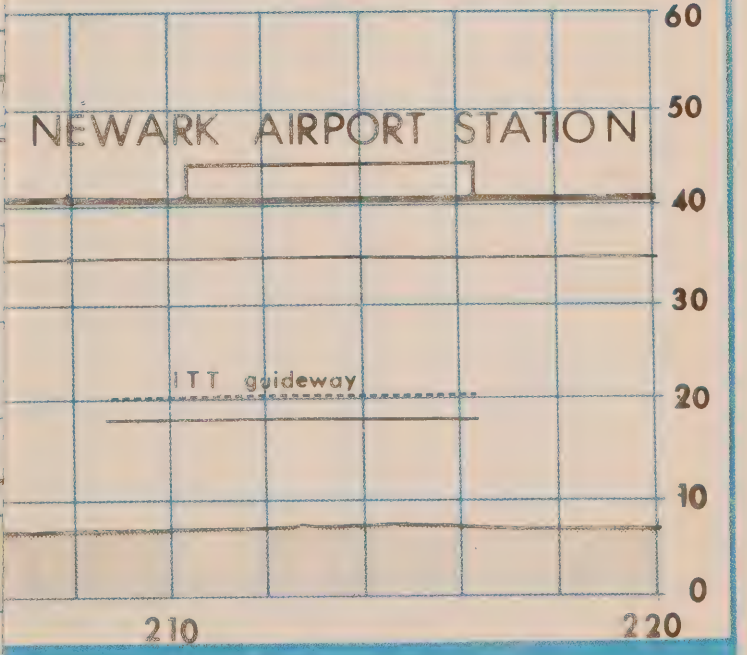
LEHIGH VALLEY RR TO PENN CENTRAL
CROSS-OVER

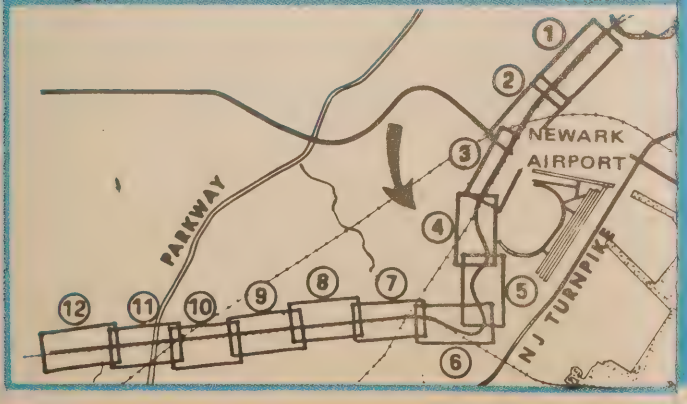
SHEET NO.: (3) STA. 100 TO STA. 160

LOUIS T. KLAUDER AND ASSOCIATES CONSULTING ENGINEERS





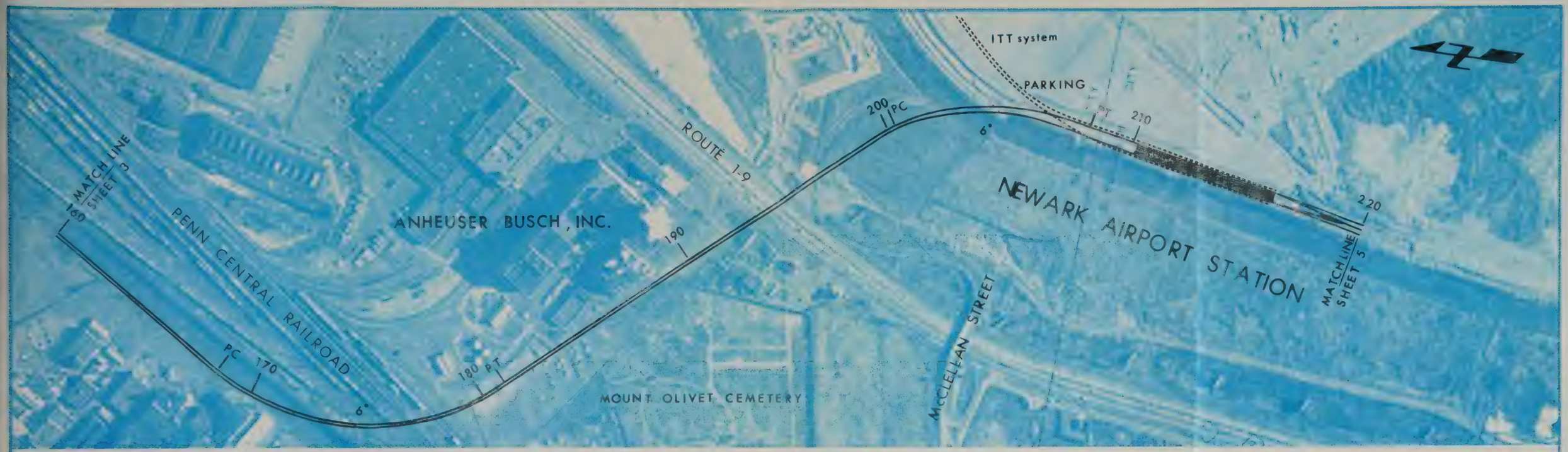


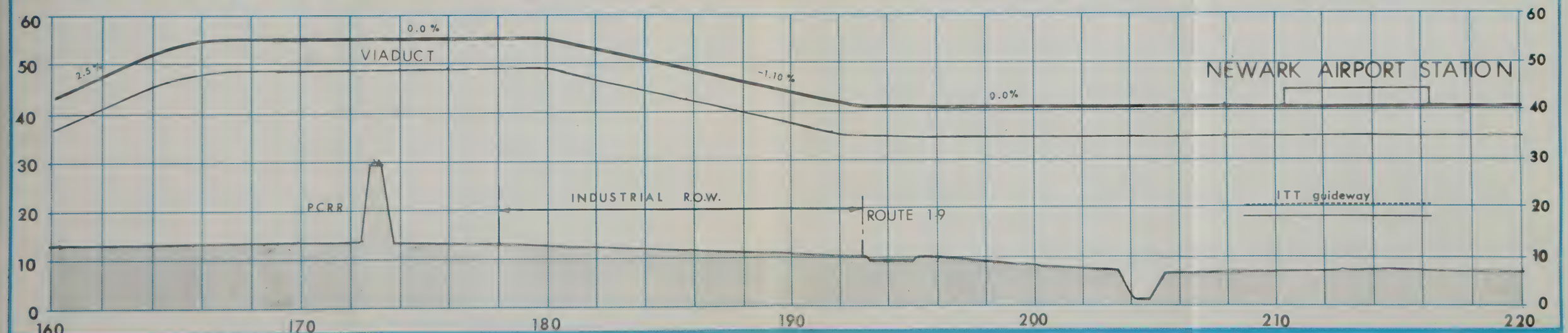


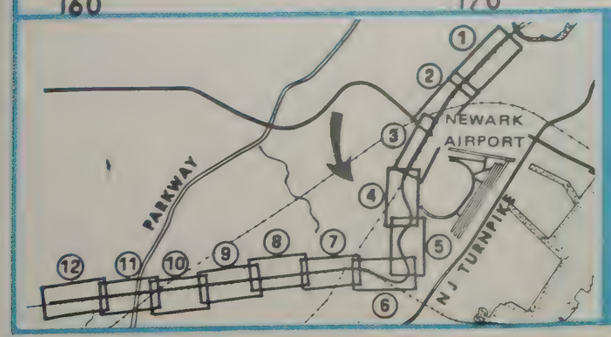
LINE SEGMENT:

PENN CENTRAL RR TO NEWARK AIRPORT STATION

SHEET NO.: (4) STA. 160 TO STA. 220







STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION
PORT OF NEW YORK AUTHORITY

ENGINEERING STUDY OF AN EXTENSION OF PATH

VIA NEWARK AIRPORT TO ELIZABETH AND WEST
ON THE CENTRAL RAILROAD OF NEW JERSEY

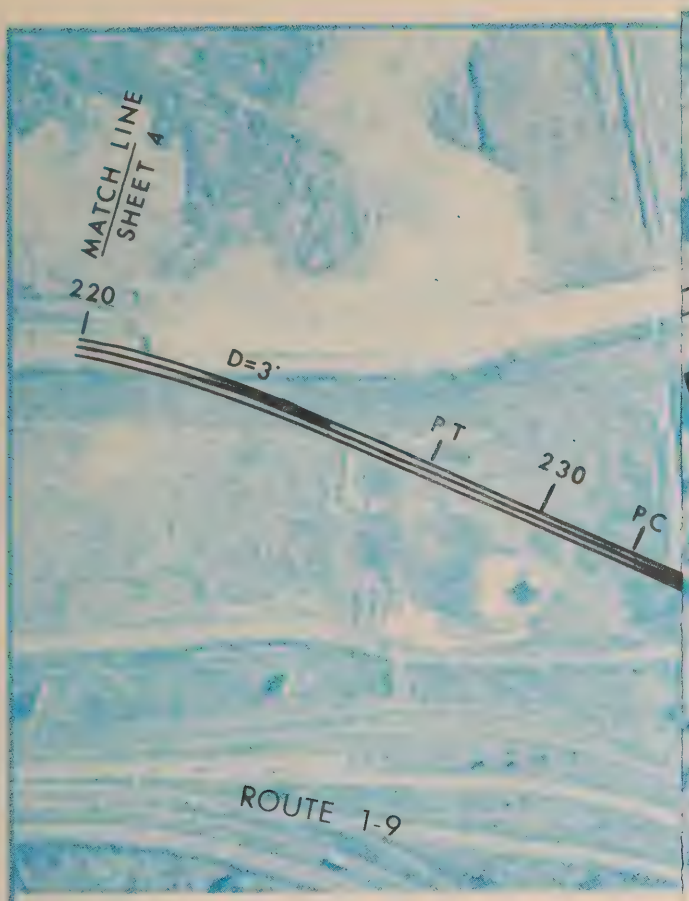
HORIZ. SCALE: 1"=400' VERT. SCALE: 1"=20'

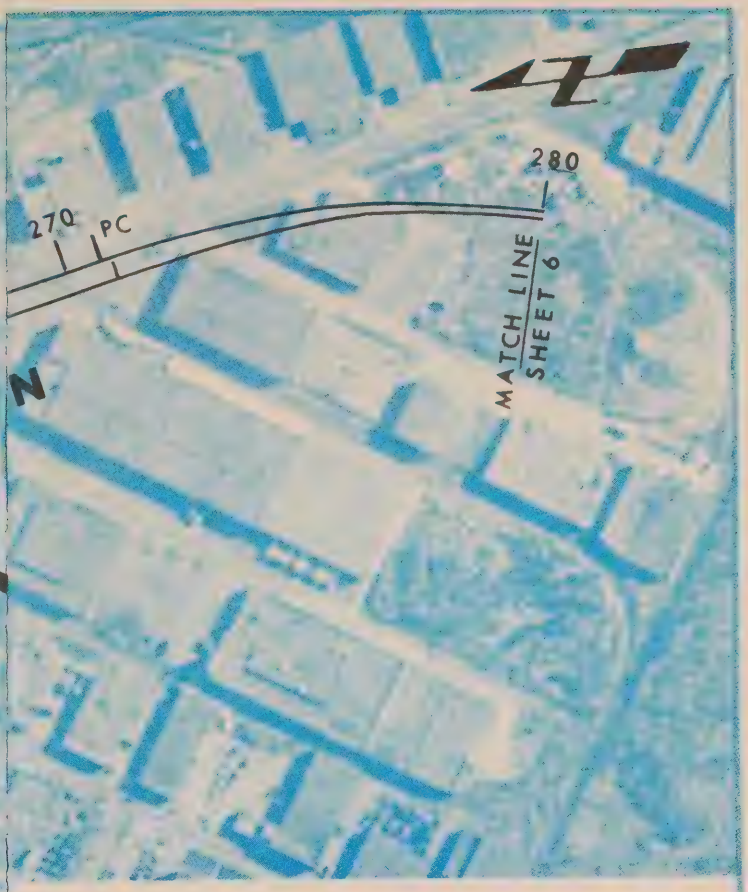
LINE SEGMENT:

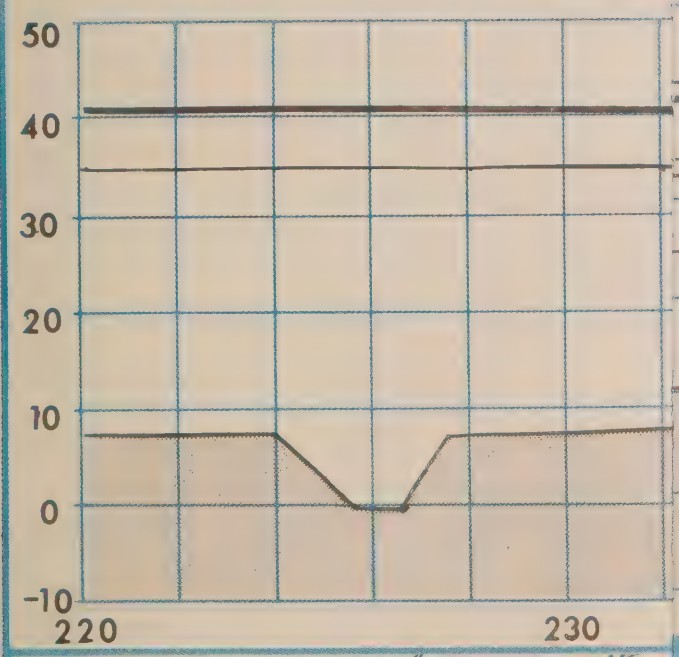
PENN CENTRAL RR TO NEWARK AIRPORT STATION

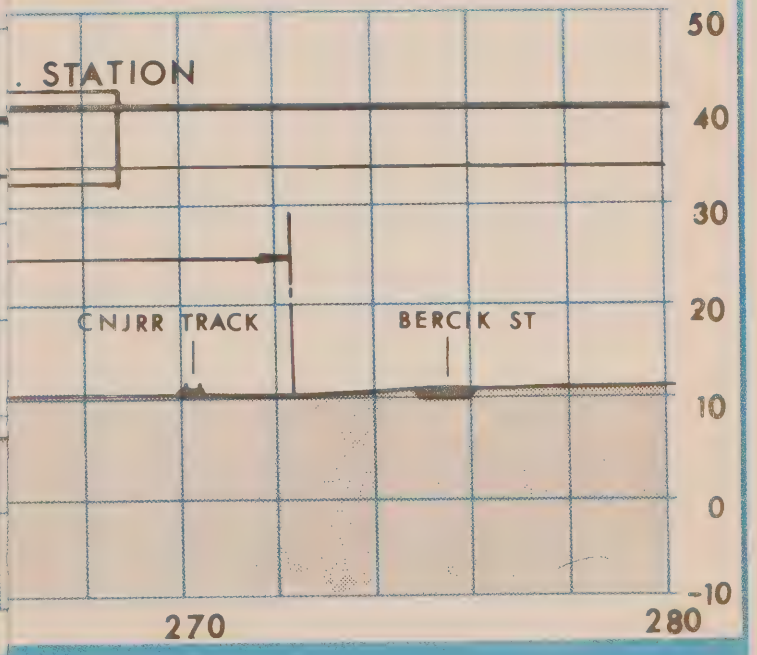
SHEET NO.: (4) STA. 160 TO STA. 220

LOUIS T. KLAUDER AND ASSOCIATES, CONSULTING ENGINEERS





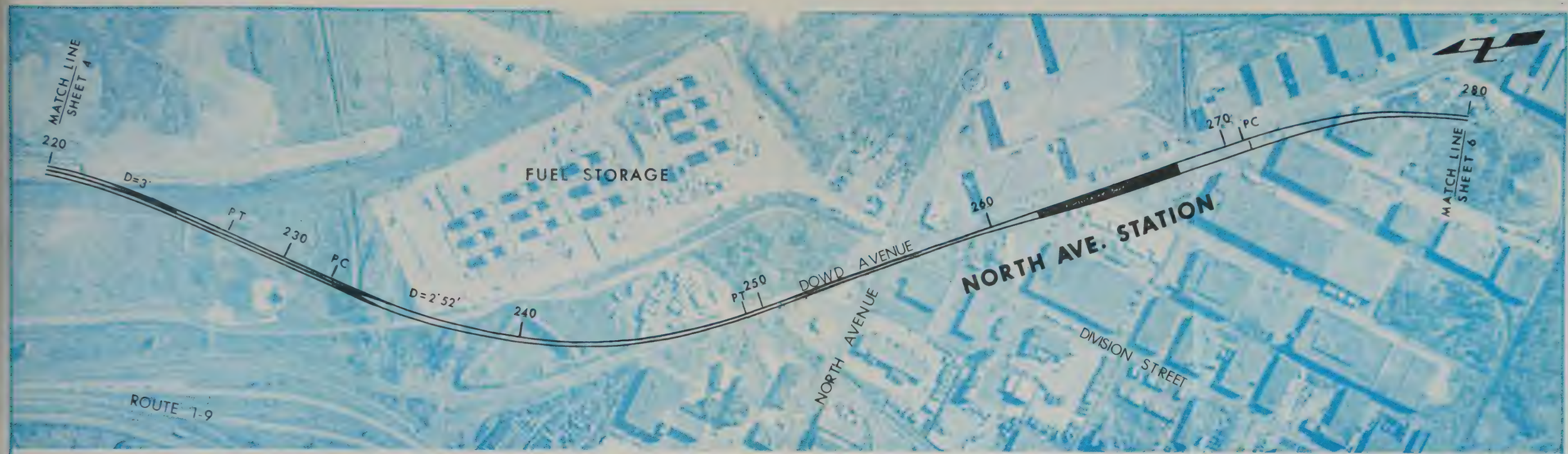


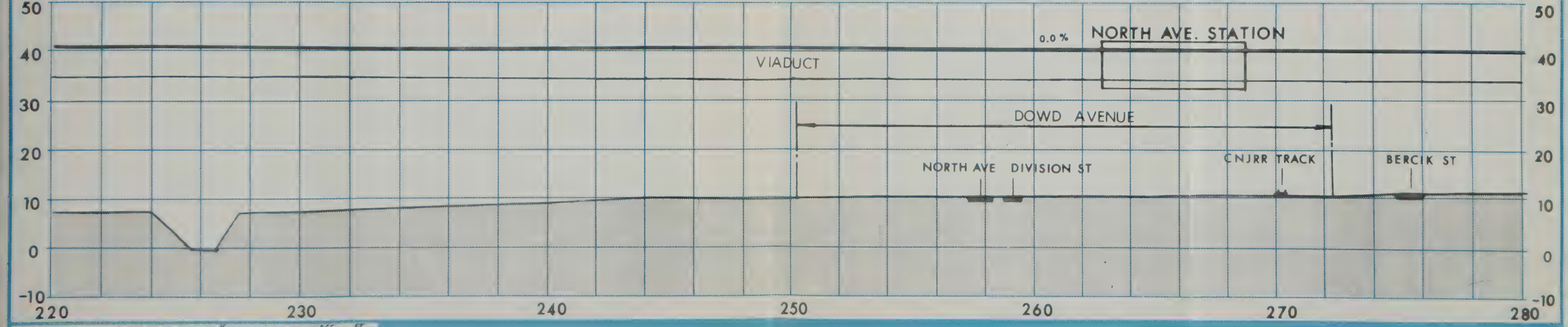


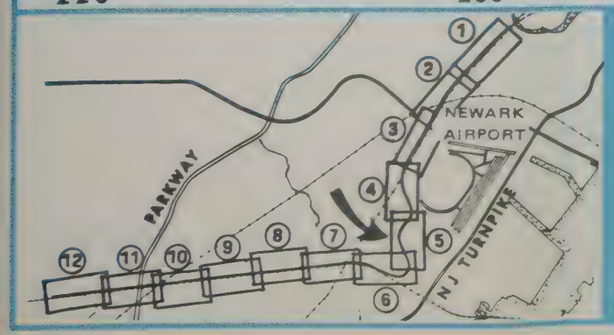
LINE SEGMENT:

NEWARK AIRPORT TO NORTH AVENUE STATION

SHEET NO.: (5) STA. 220 TO STA. 280







STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION
PORT OF NEW YORK AUTHORITY

ENGINEERING STUDY OF AN EXTENSION OF PATH

VIA NEWARK AIRPORT TO ELIZABETH AND WEST
ON THE CENTRAL RAILROAD OF NEW JERSEY

HORIZ. SCALE: 1"=400'

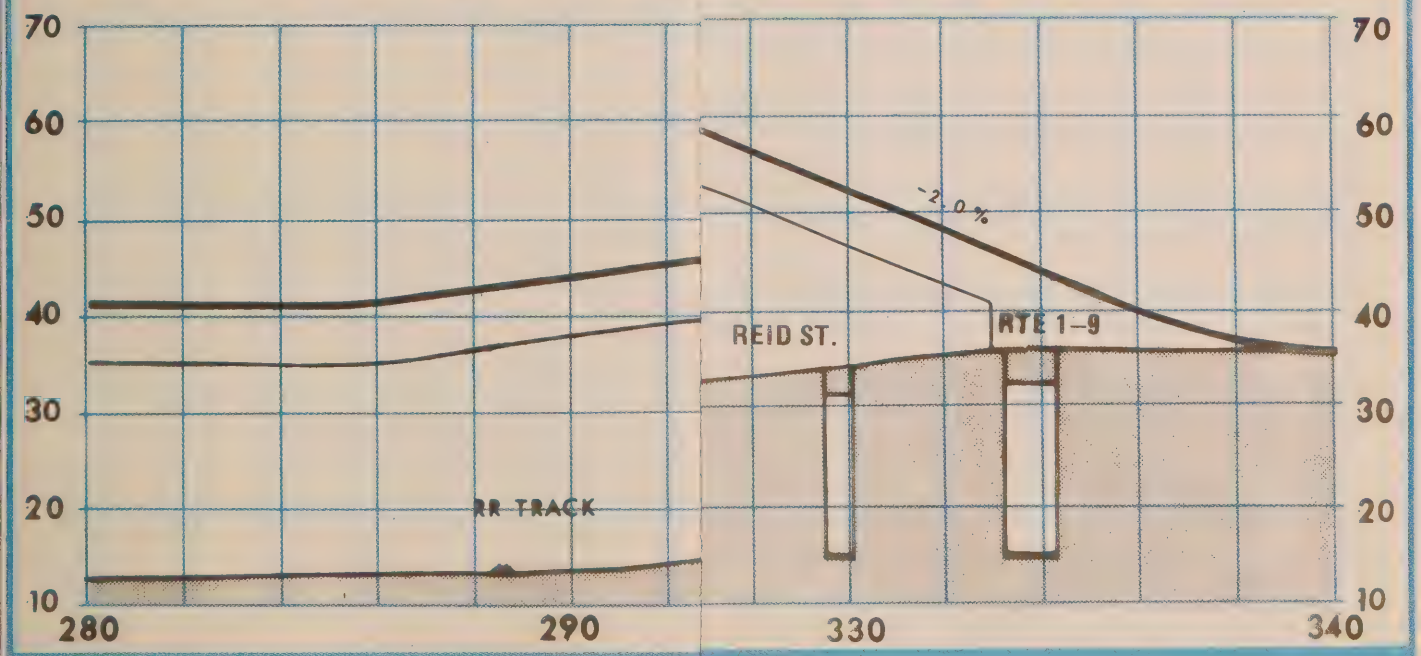
VERT. SCALE: 1"=20'

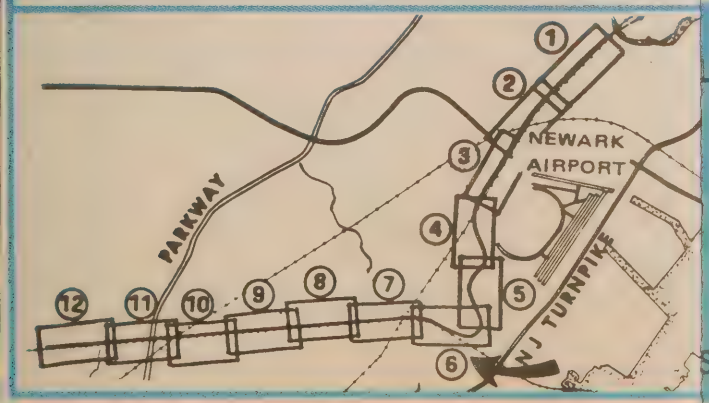
LINE SEGMENT:

NEWARK AIRPORT TO NORTH AVENUE STATION

SHEET NO.: (5) STA. 220 TO STA. 280

LOUIS T. KLAUDER AND ASSOCIATES, CONSULTING ENGINEERS

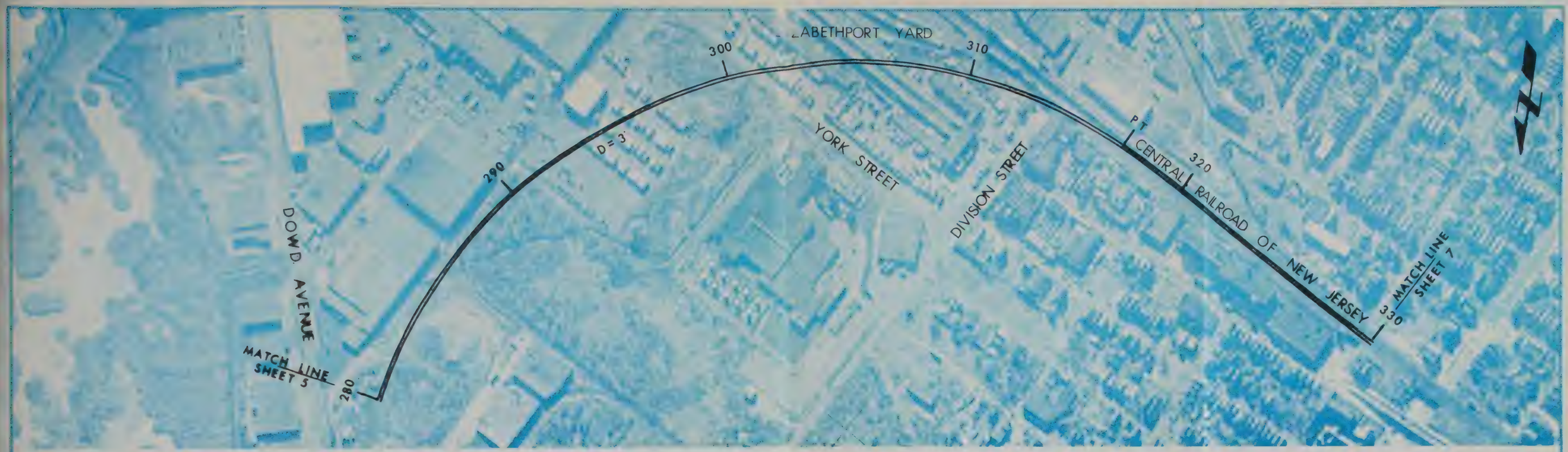


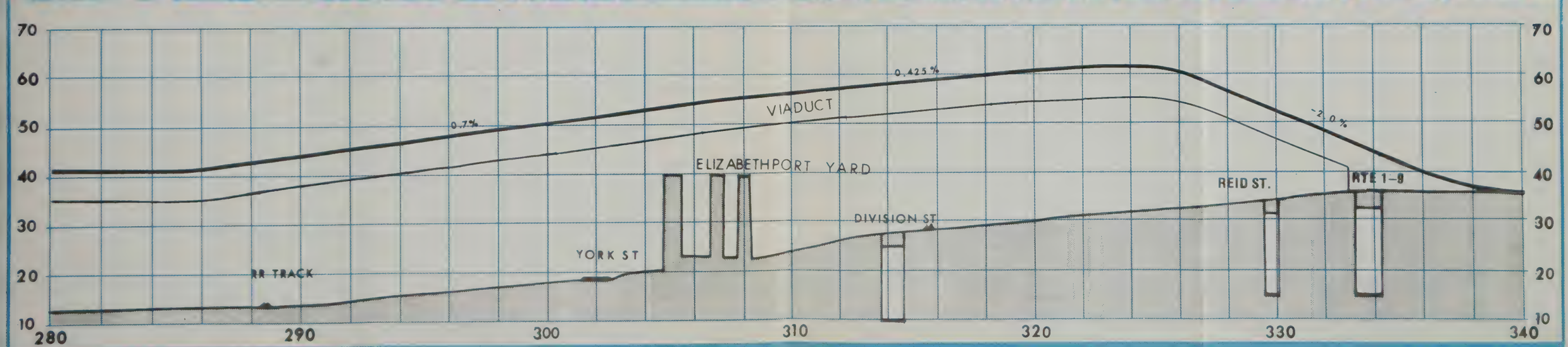


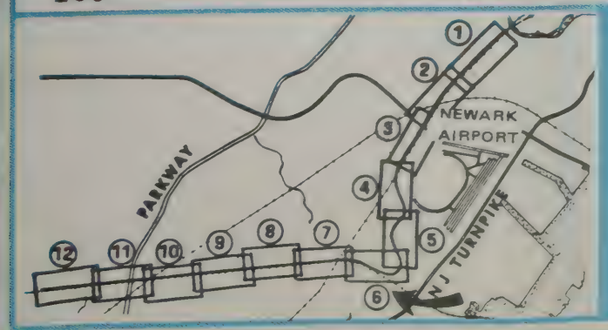
LINE SEGMENT:

NORTH AVENUE STATION TO RTE 1-9

SHEET NO.: (6) STA. 280 TO STA. 330







STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION
PORT OF NEW YORK AUTHORITY

ENGINEERING STUDY OF AN EXTENSION OF PATH

VIA NEWARK AIRPORT TO ELIZABETH AND WEST
ON THE CENTRAL RAILROAD OF NEW JERSEY

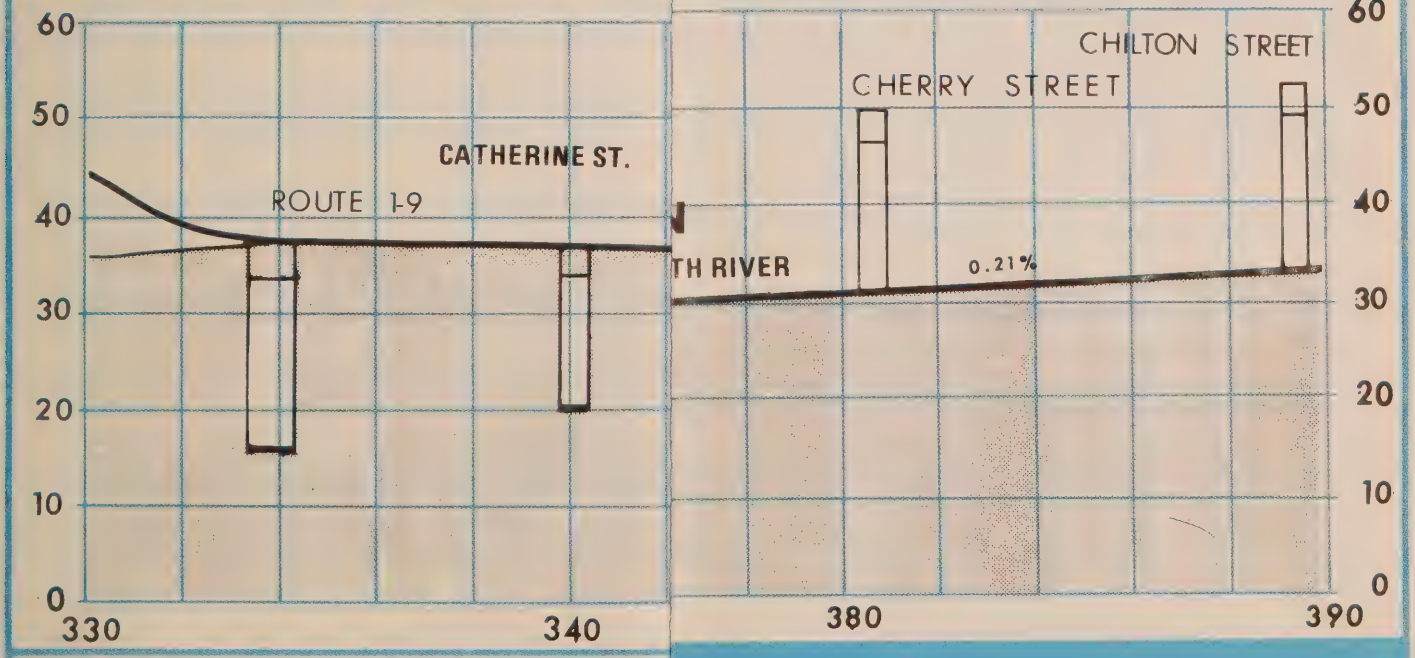
HORIZ. SCALE: 1"=400' VERT. SCALE: 1"=20'

LINE SEGMENT:

NORTH AVENUE STATION TO RTE 1-9

SHEET NO.: 6 STA. 280 TO STA. 330

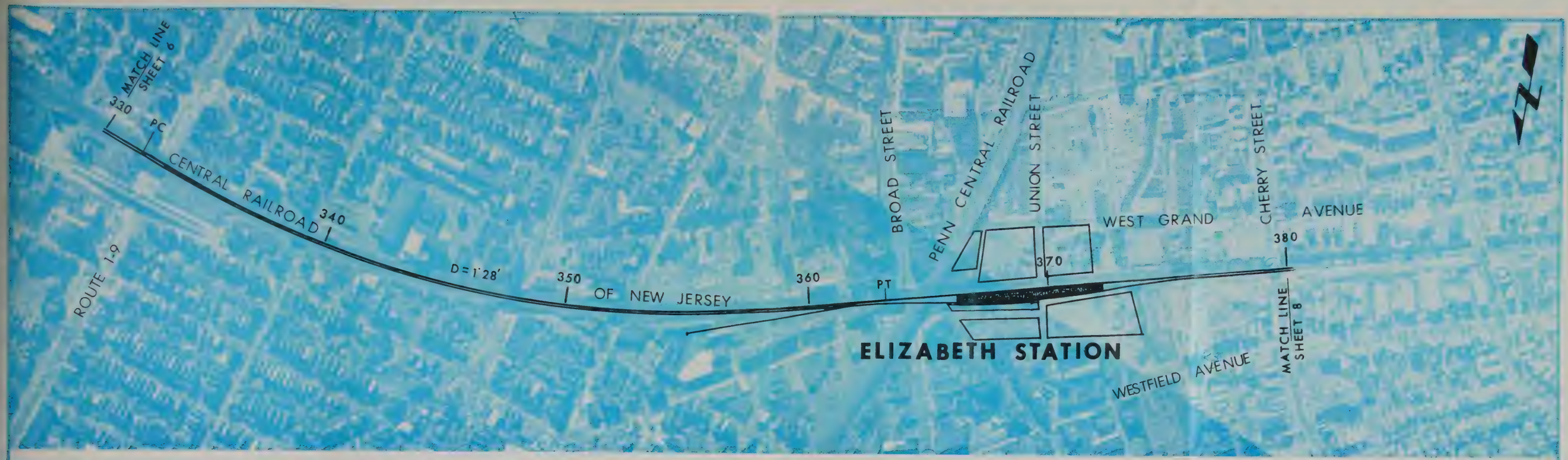
LOUIS T. KLAUDER AND ASSOCIATES, CONSULTING ENGINEERS

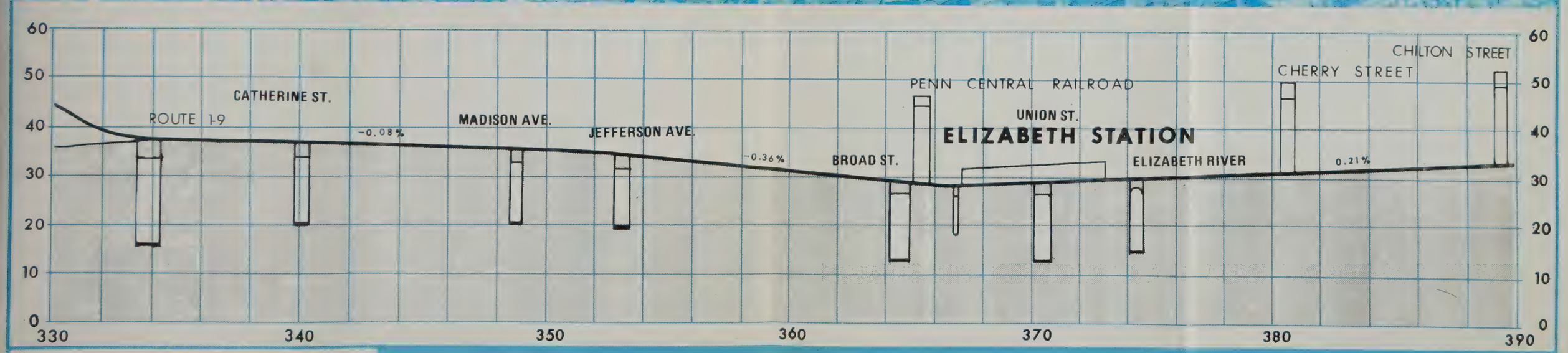


LINE SEGMENT:

RTE 1-9 TO WEST ELIZABETH

SHEET NO.: (7) STA. 330 TO STA. 380





STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION
PORT OF NEW YORK AUTHORITY

ENGINEERING STUDY OF AN EXTENSION OF PATH

VIA NEWARK AIRPORT TO ELIZABETH AND WEST
ON THE CENTRAL RAILROAD OF NEW JERSEY

HORIZ. SCALE: 1"=400'

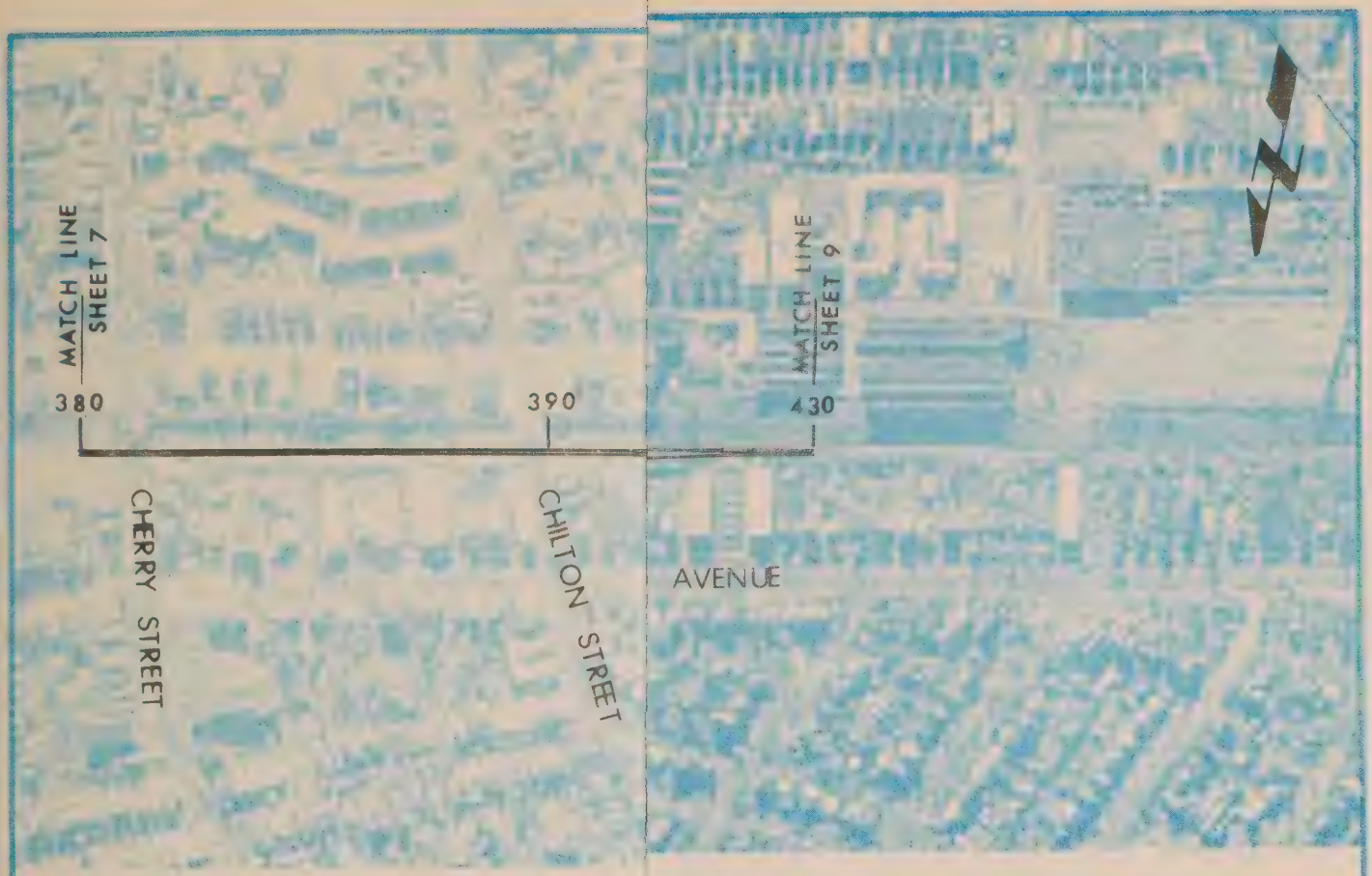
VERT. SCALE: 1"=20'

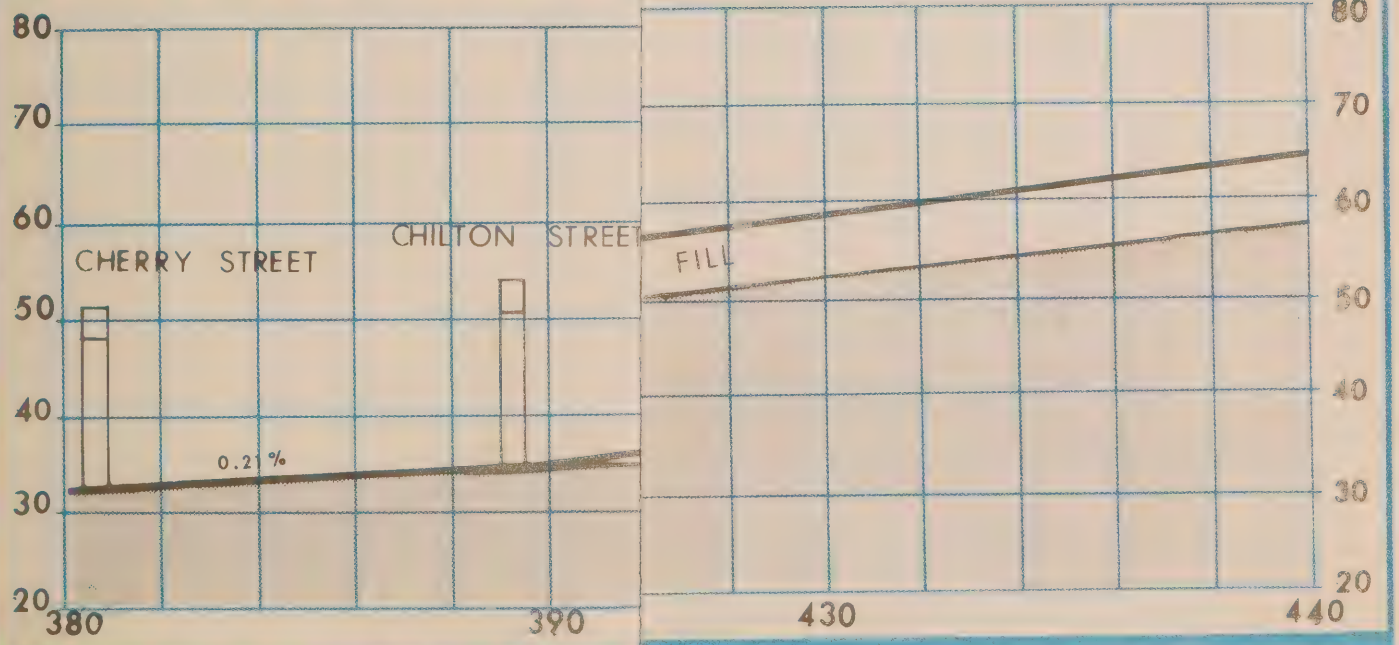
LINE SEGMENT:

RTE 1-9 TO WEST ELIZABETH

SHEET NO.: (7) STA. 330 TO STA. 380

LOUIS T. KLAUDER AND ASSOCIATES, CONSULTING ENGINEERS

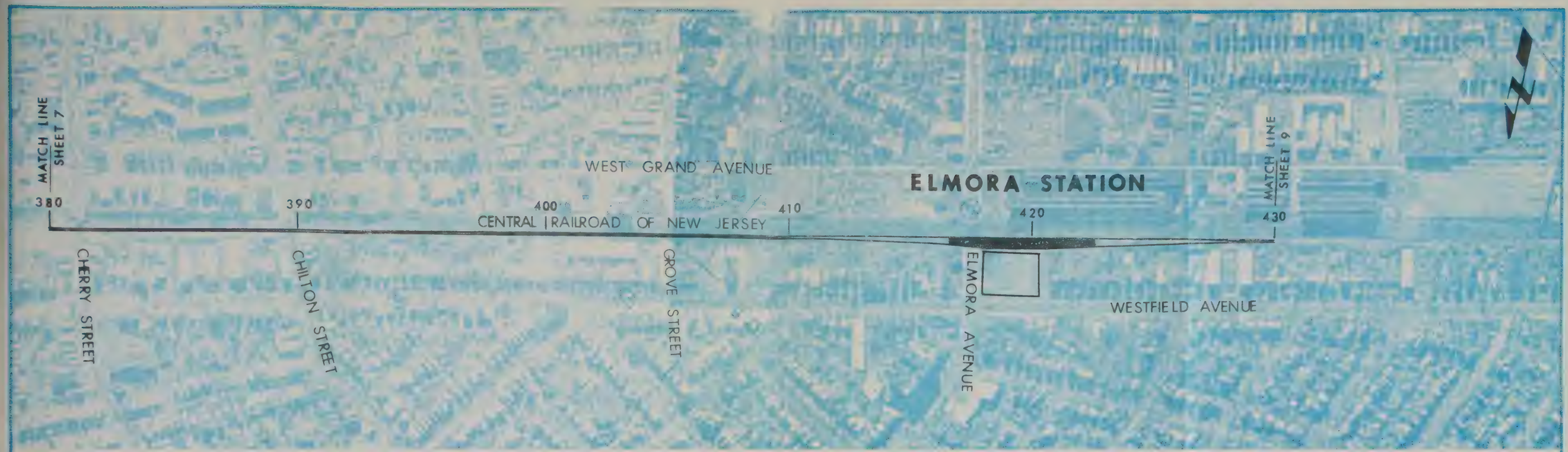


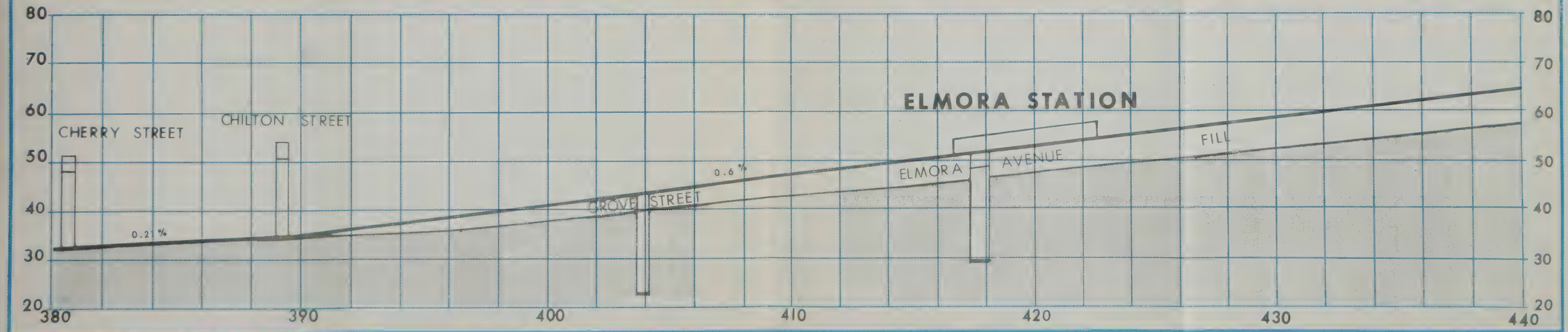


LINE SEGMENT:

WEST ELIZABETH TO ELMORA

SHEET NO.: (8) STA. 380 TO STA. 430





STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION
PORT OF NEW YORK AUTHORITY

ENGINEERING STUDY OF AN EXTENSION OF PATH

VIA NEWARK AIRPORT TO ELIZABETH AND WEST
ON THE CENTRAL RAILROAD OF NEW JERSEY

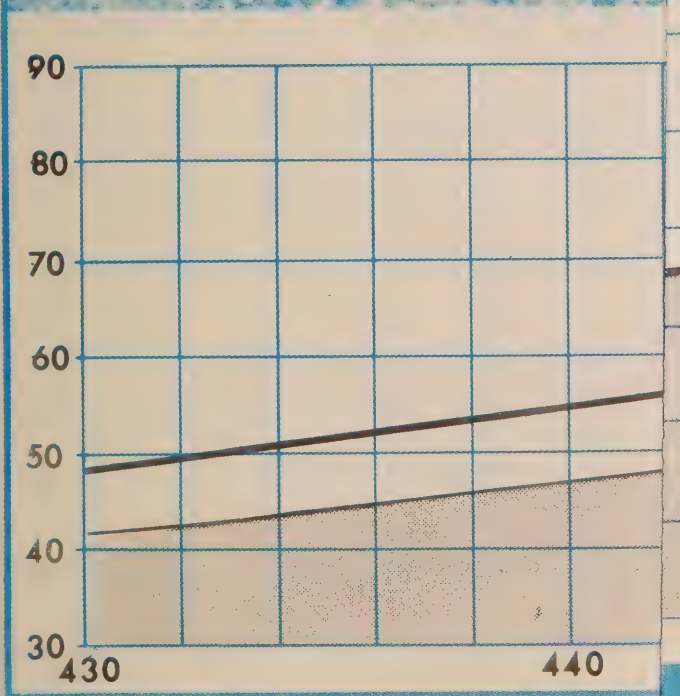
HORIZ. SCALE: 1" = 400' VERT. SCALE: 1" = 20'

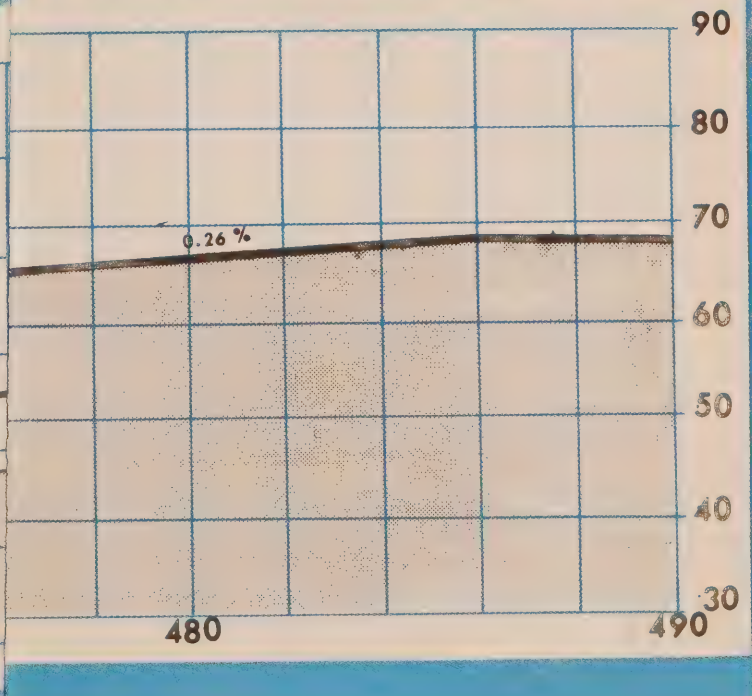
LINE SEGMENT:

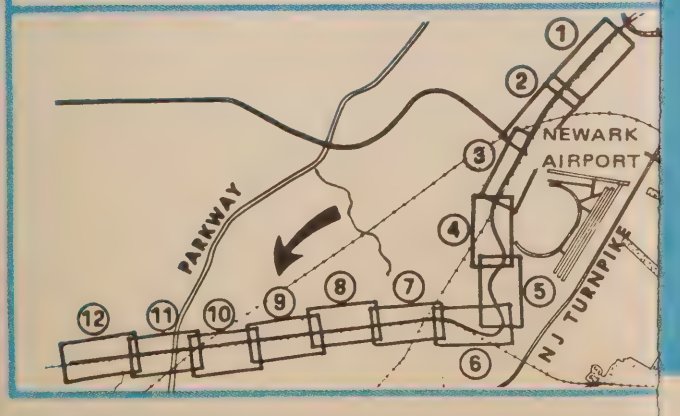
WEST ELIZABETH TO ELMORA

SHEET NO.: (8) STA. 380 TO STA. 430

LOUIS T. KLAUDER AND ASSOCIATES, CONSULTING ENGINEERS



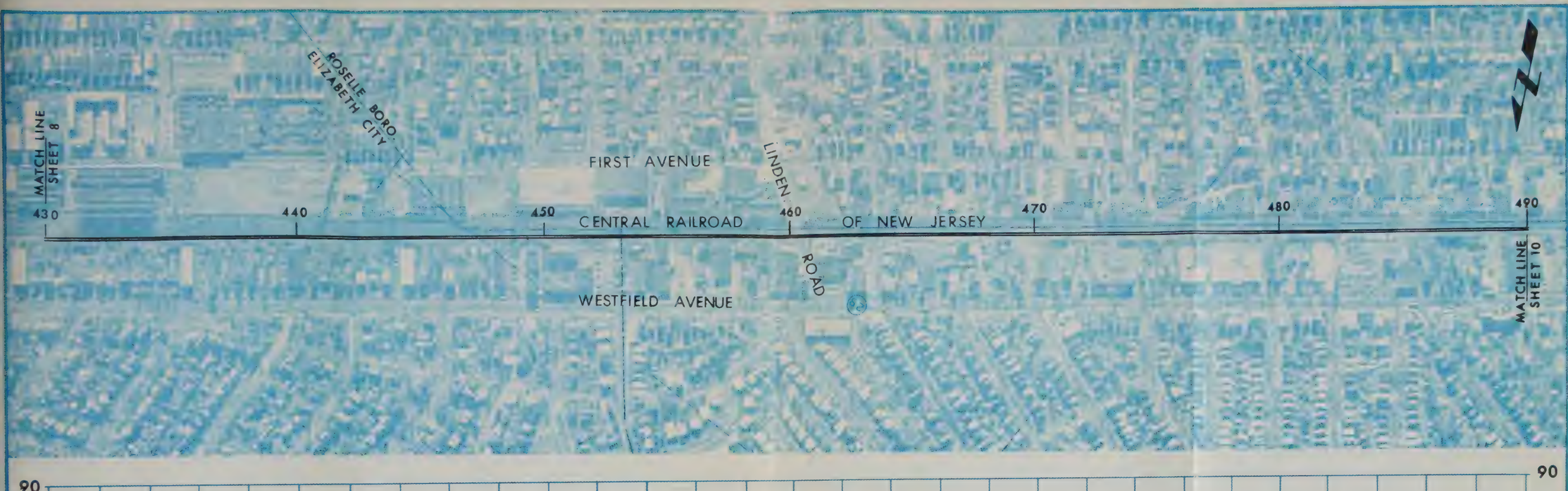




LINE SEGMENT:

ELMORA TO ROSELLE

SHEET NO.: (9) STA. 430 TO STA. 490



STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION
PORT OF NEW YORK AUTHORITY

ENGINEERING STUDY OF AN EXTENSION OF PATH

VIA NEWARK AIRPORT TO ELIZABETH AND WEST
ON THE CENTRAL RAILROAD OF NEW JERSEY

HORIZ. SCALE: 1"=400'

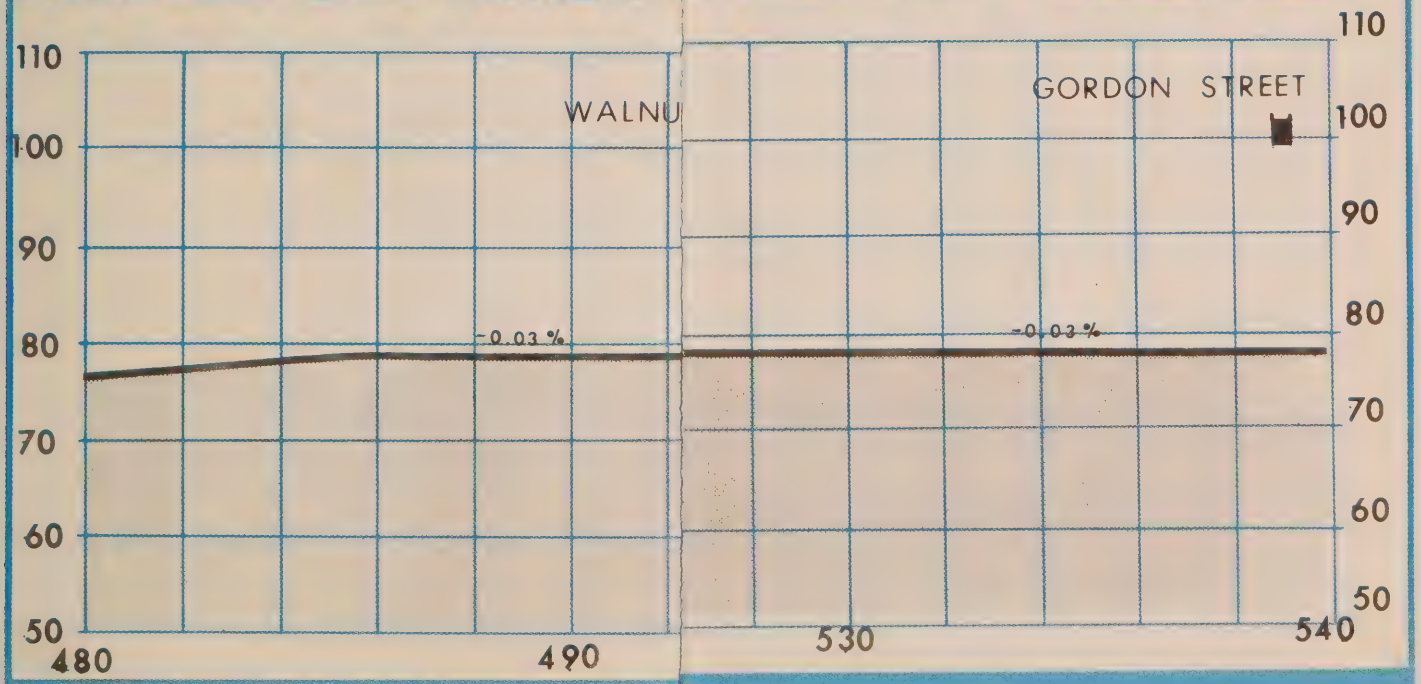
VERT. SCALE: 1"=20'

LINE SEGMENT:

ELMORA TO ROSELLE

SHEET NO.: (9) STA. 430 TO STA. 490

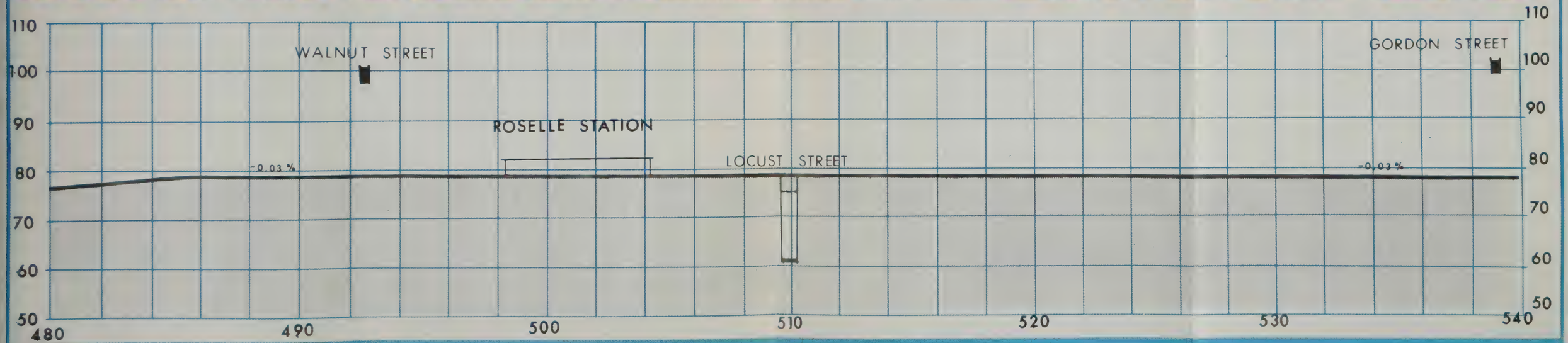
LOUIS T. KLAUDER AND ASSOCIATES, CONSULTING ENGINEERS



LINE SEGMENT:

ROSELLE TO ALDENE

SHEET NO.: (10) STA. 490 TO STA. 540



STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION
PORT OF NEW YORK AUTHORITY

ENGINEERING STUDY OF AN EXTENSION OF PATH

VIA NEWARK AIRPORT TO ELIZABETH AND WEST
ON THE CENTRAL RAILROAD OF NEW JERSEY

HORIZ. SCALE: 1"=400'

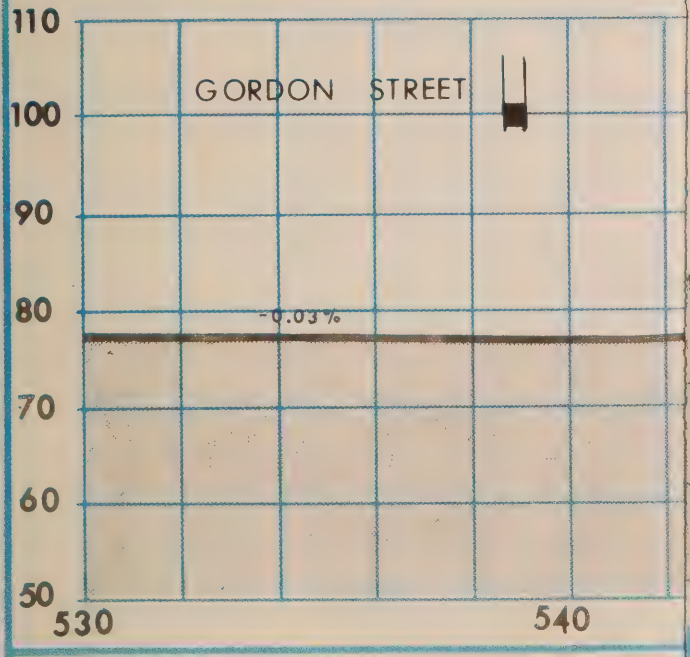
VERT. SCALE: 1"=20'

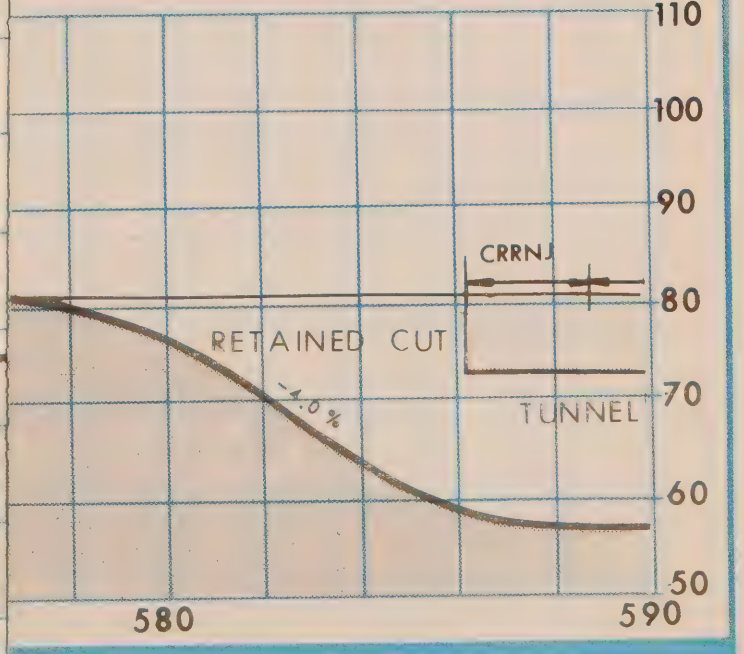
LINE SEGMENT:

ROSELLE TO ALDENE

SHEET NO.: (10) STA. 490 TO STA. 540

LOUIS T. KLAUDER AND ASSOCIATES, CONSULTING ENGINEERS

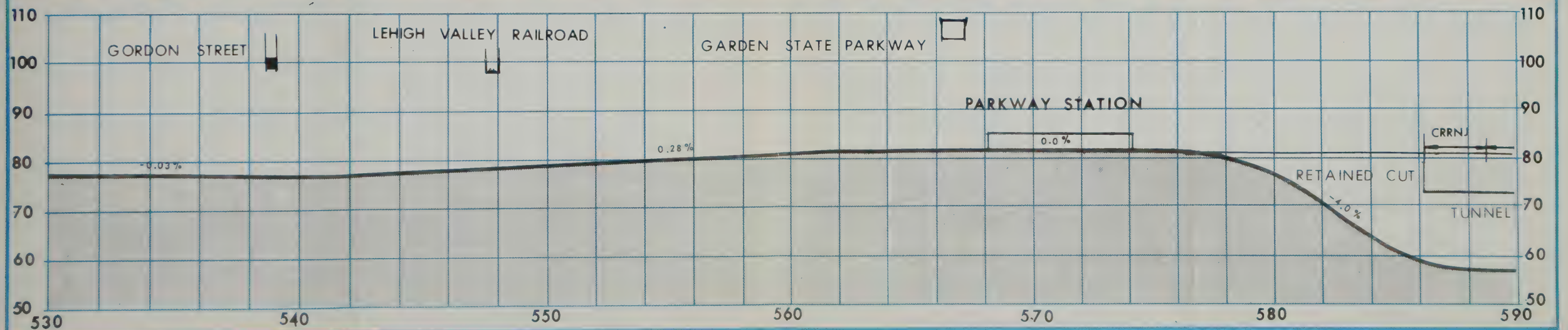


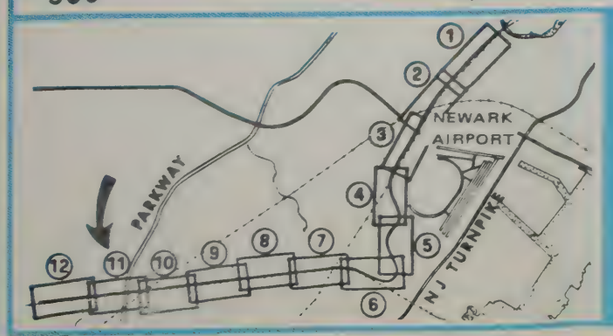


LINE SEGMENT:

PARKWAY STATION

SHEET NO.: (11) STA. 540 TO STA. 590





STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION
PORT OF NEW YORK AUTHORITY

ENGINEERING STUDY OF AN EXTENSION OF PATH

VIA NEWARK AIRPORT TO ELIZABETH AND WEST
ON THE CENTRAL RAILROAD OF NEW JERSEY

HORIZ. SCALE: 1"=400'

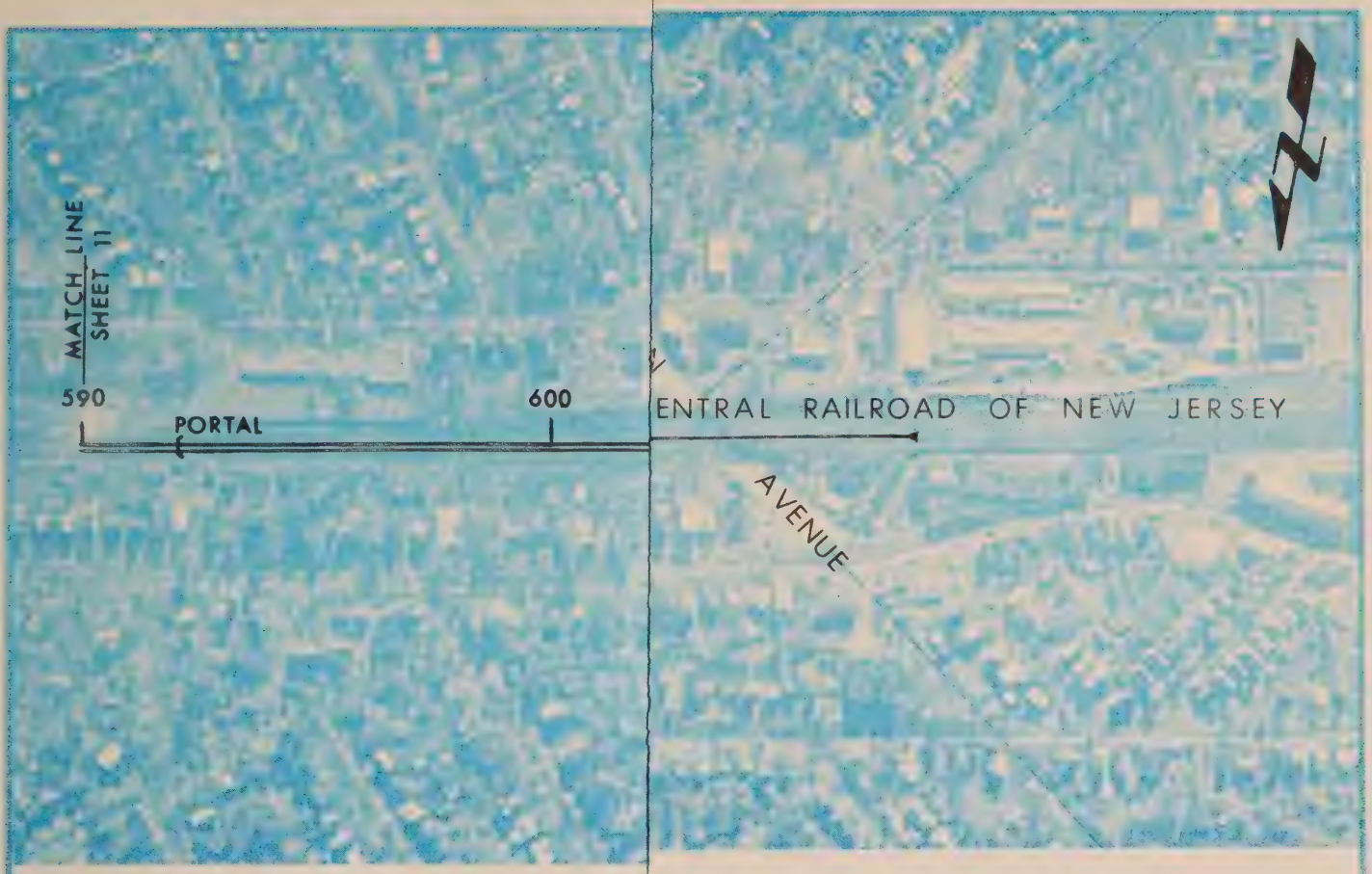
VERT. SCALE: 1"=20'

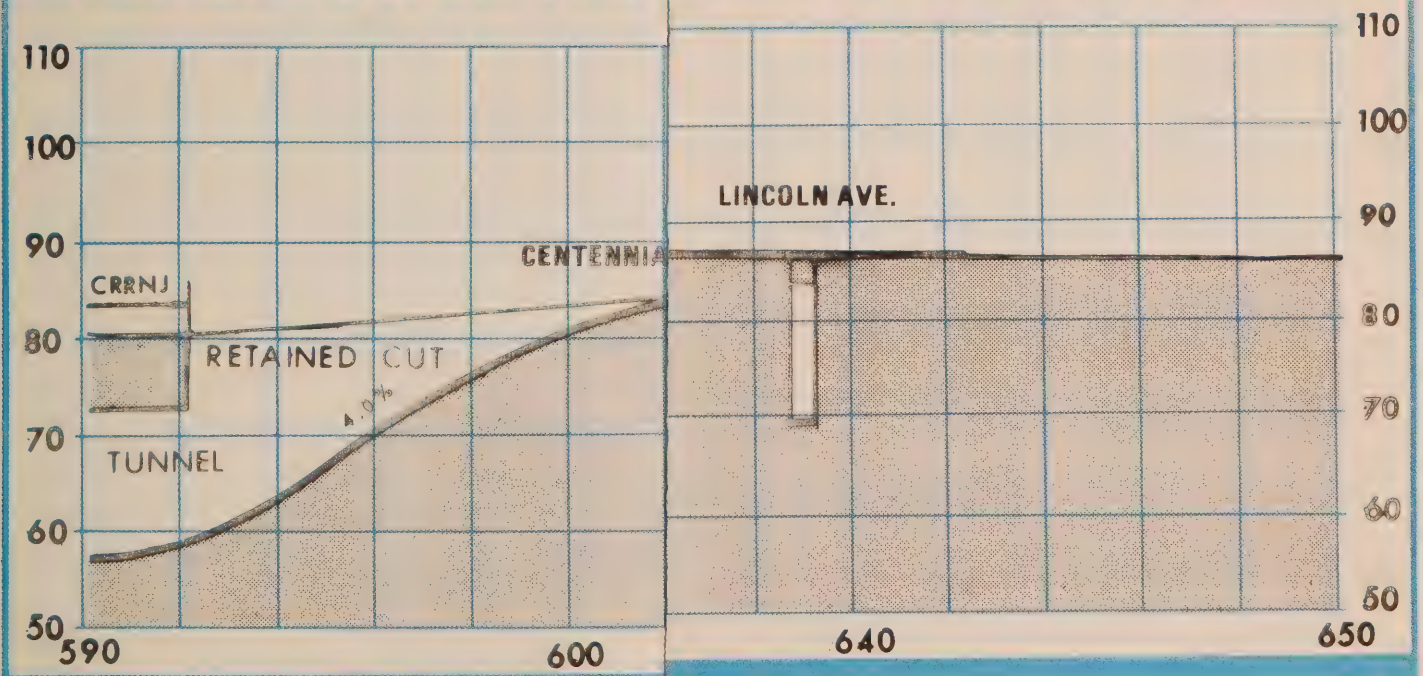
LINE SEGMENT:

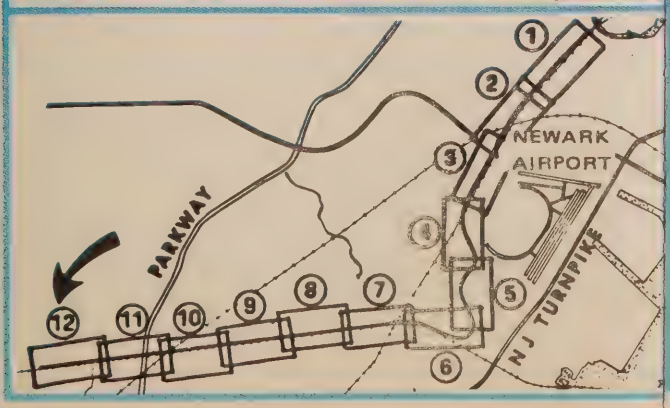
PARKWAY STATION

SHEET NO.: (11) STA. 540 TO STA. 590

LOUIS T. KLAUDER AND ASSOCIATES, CONSULTING ENGINEERS



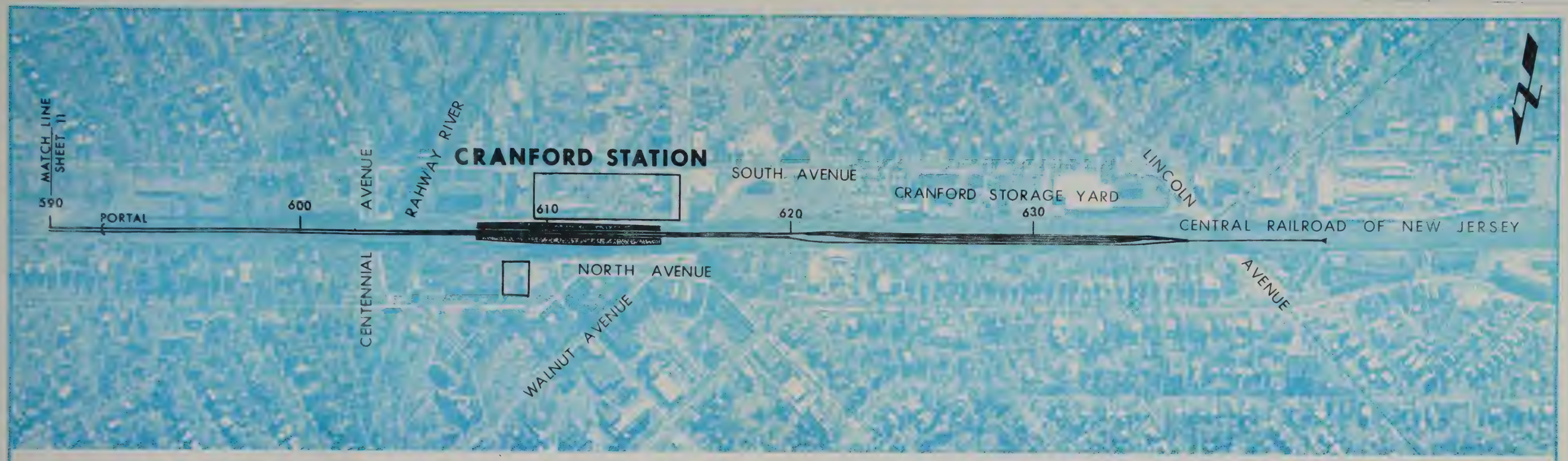


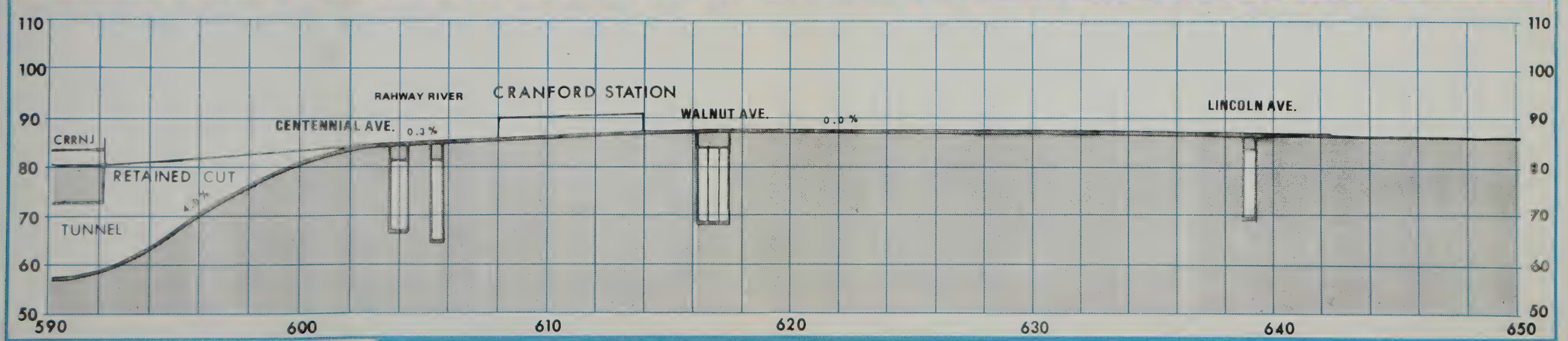


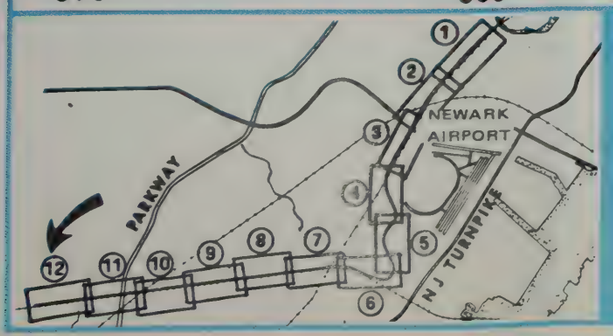
LINE SEGMENT:

CRANFORD

SHEET NO.: (12) STA. 590 TO STA. 642







STATE OF NEW JERSEY DEPARTMENT OF TRANSPORTATION
PORT OF NEW YORK AUTHORITY

ENGINEERING STUDY OF AN EXTENSION OF PATH

VIA NEWARK AIRPORT TO ELIZABETH AND WEST
ON THE CENTRAL RAILROAD OF NEW JERSEY

LINE SEGMENT:

CRANFORD

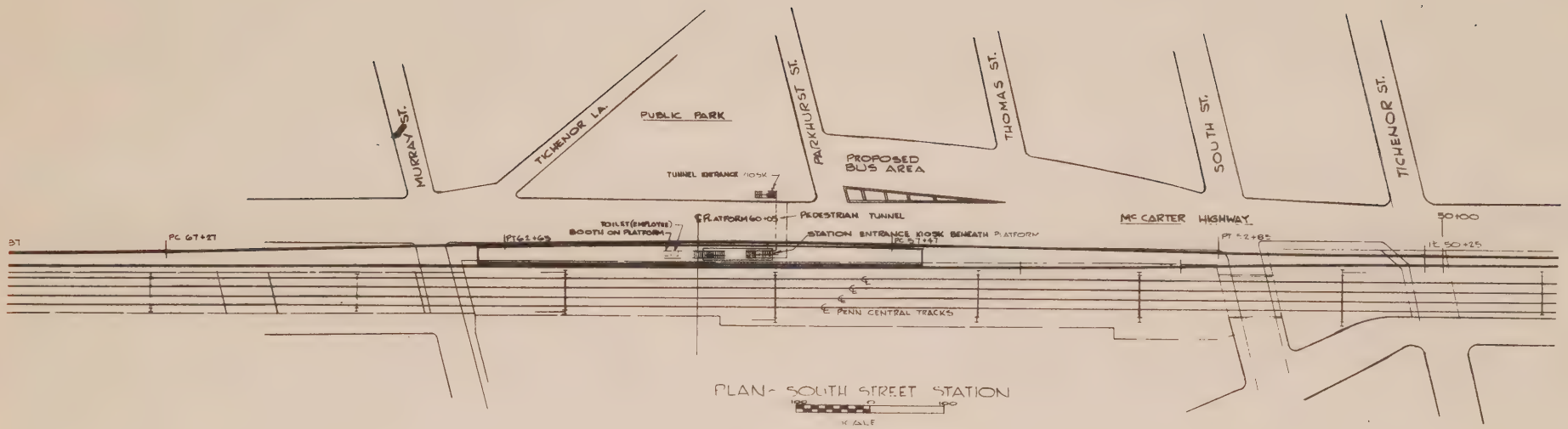
HORIZ. SCALE: 1"=400'

VERT. SCALE: 1"=20'

SHEET NO.: (12) STA. 590 TO STA. 642

LOUIS T. KLAUDER AND ASSOCIATES, CONSULTING ENGINEERS

APPENDIX B



PLAN - SOUTH STREET STATION

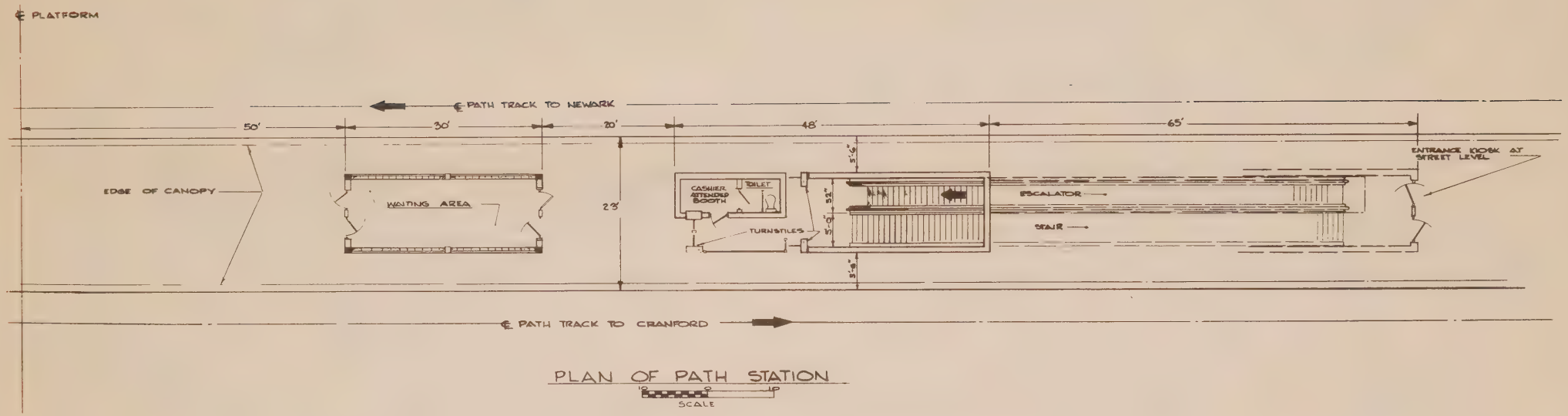
SCALE

EXTENSION OF PATH VIA NEWARK AIRPORT
TO ELIZABETH & CRANFORD

SOUTH STREET STATION

LOUIS T. KLAUDER AND ASSOCIATES

PLATE NO. B-1A



PLAN OF PATH STATION

SCALE

EXTENSION OF PATH VIA NEWARK AIRPORT
TO ELIZABETH & CRANFORD

NORTH AVE. & SOUTH ST.
PLATFORM STATION

LOUIS T. KLAUDER AND ASSOCIATES

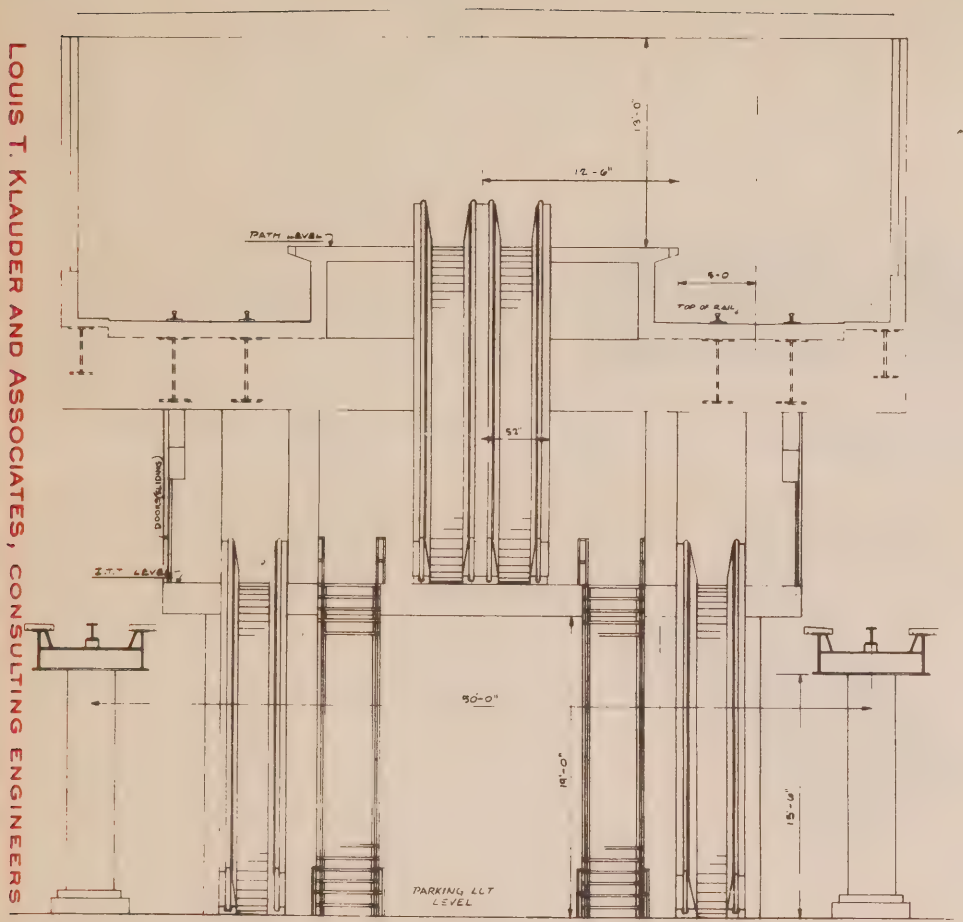
PLATE NO. B-18

EXTENSION OF PATH VIA NEWARK AIRPORT TO ELIZABETH & CRANFORD

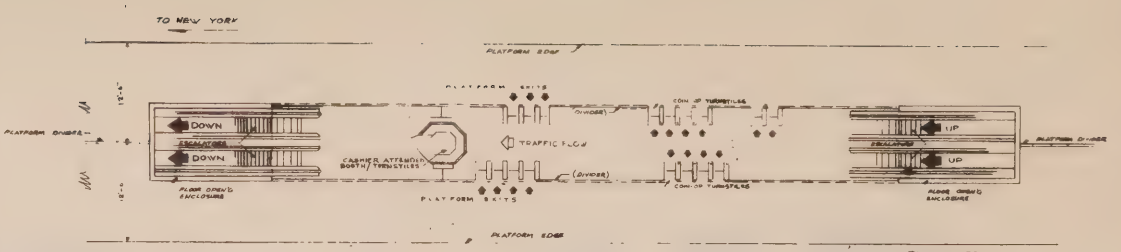
NEWARK AIRPORT STATION

LOUIS T. KLAUDER AND ASSOCIATES

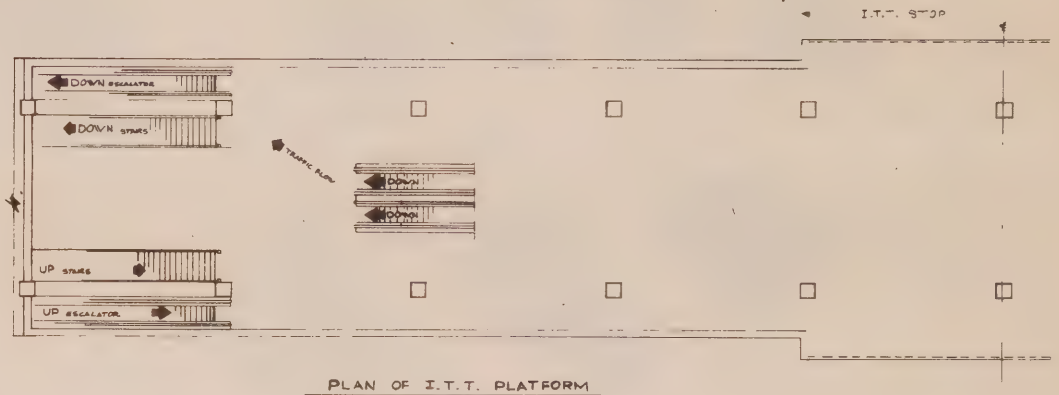
PLATE NO. B-2A



SECTION OF I.T.T-PATH STATION



PLAN OF PATH PLATFORM



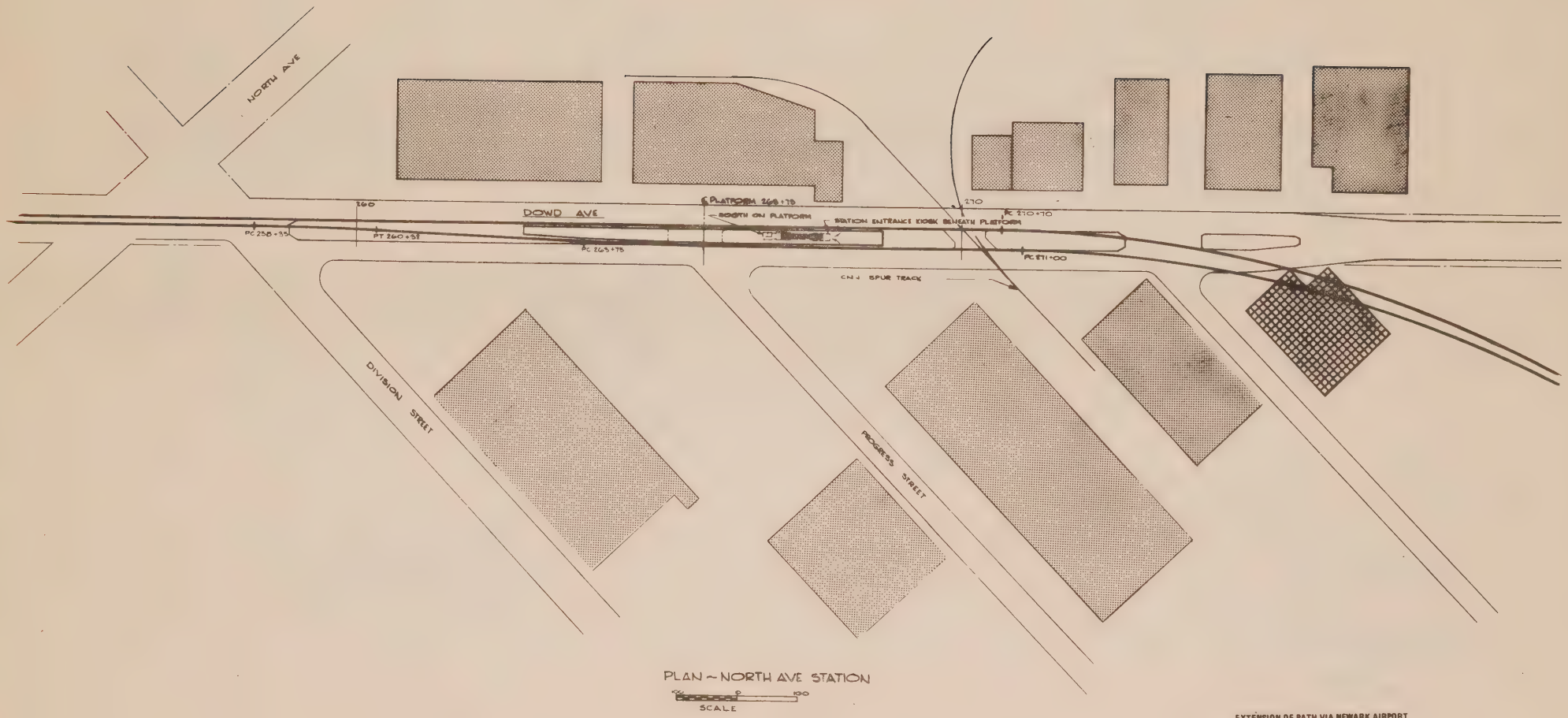
PLAN OF I.T.T. PLATFORM

EXTENSION OF PATH VIA NEWARK AIRPORT
TO ELIZABETH & CRANFORD

NEWARK AIRPORT STATION

LOUIS T. KLAUDER AND ASSOCIATES

PLATE NO. B-2 B



PLAN – NORTH AVE STATION

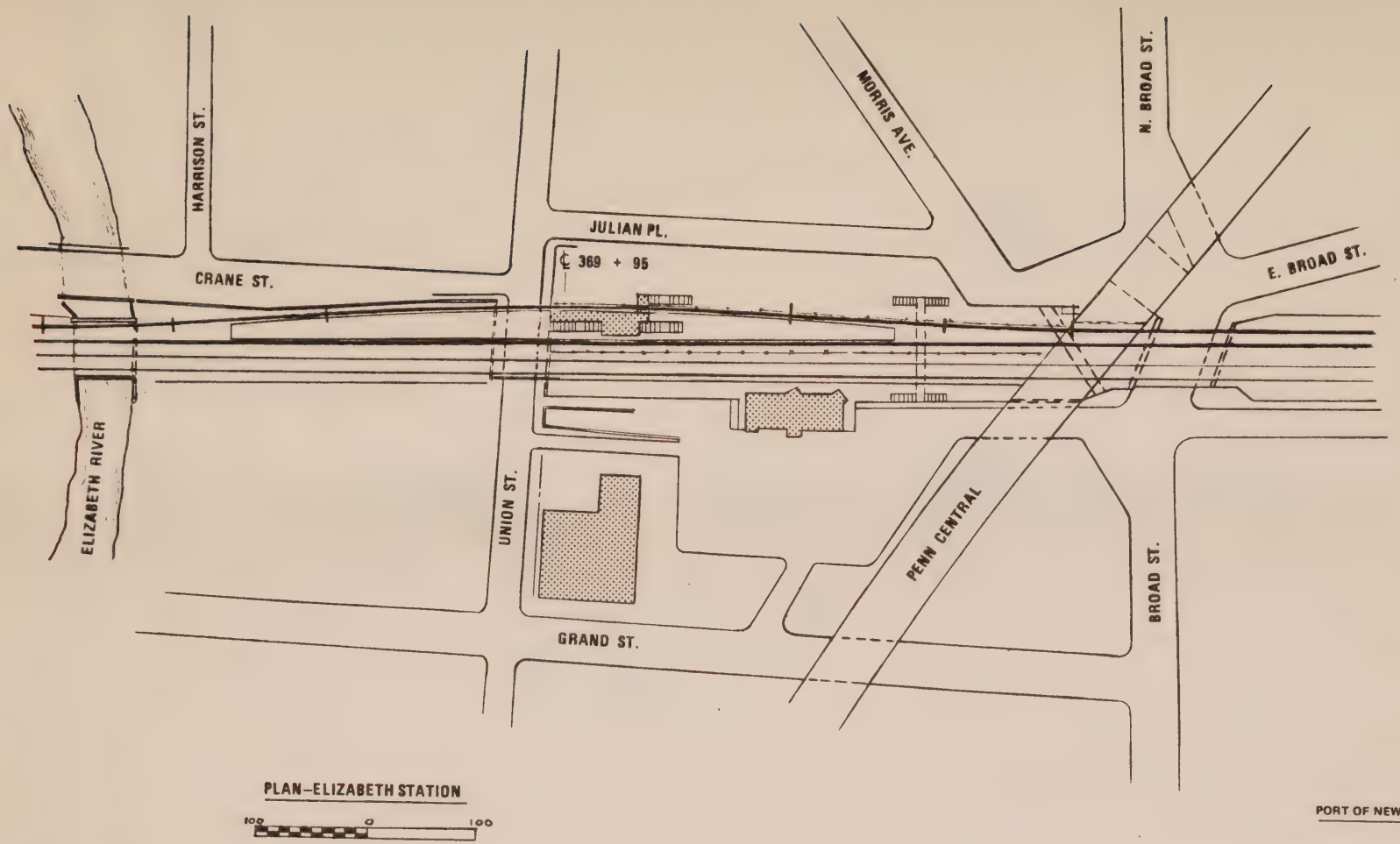
SCALE 100

EXTENSION OF PATH VIA NEWARK AIRPORT TO ELIZABETH & CRANFORD

NORTH AVE. STATION

LOUIS T. KLAUDER AND ASSOCIATES

PLATE NO. B-3A



PLAN–ELIZABETH STATION

100 0 100

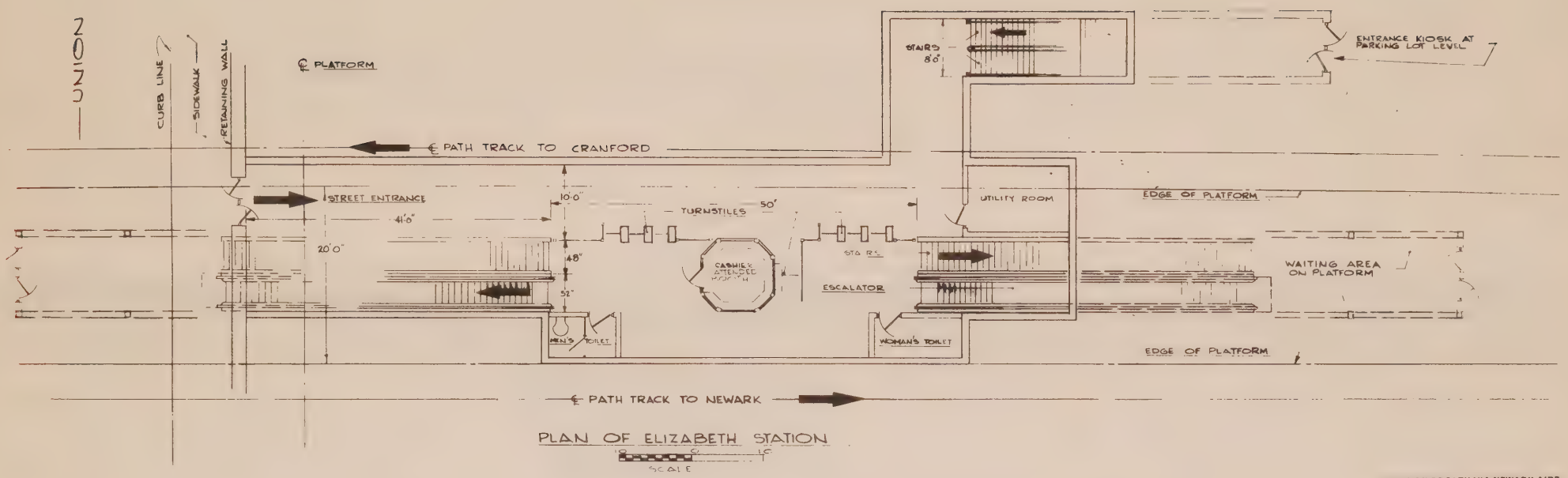
PORT OF NEW YORK AUTHORITY

EXTENSION OF PATH VIA NEWARK AIRPORT
TO ELIZABETH & CRANFORD

ELIZABETH STATION

LOUIS T. KLAUDER AND ASSOCIATES

PLATE NO. B–4A



PLAN OF ELIZABETH STATION

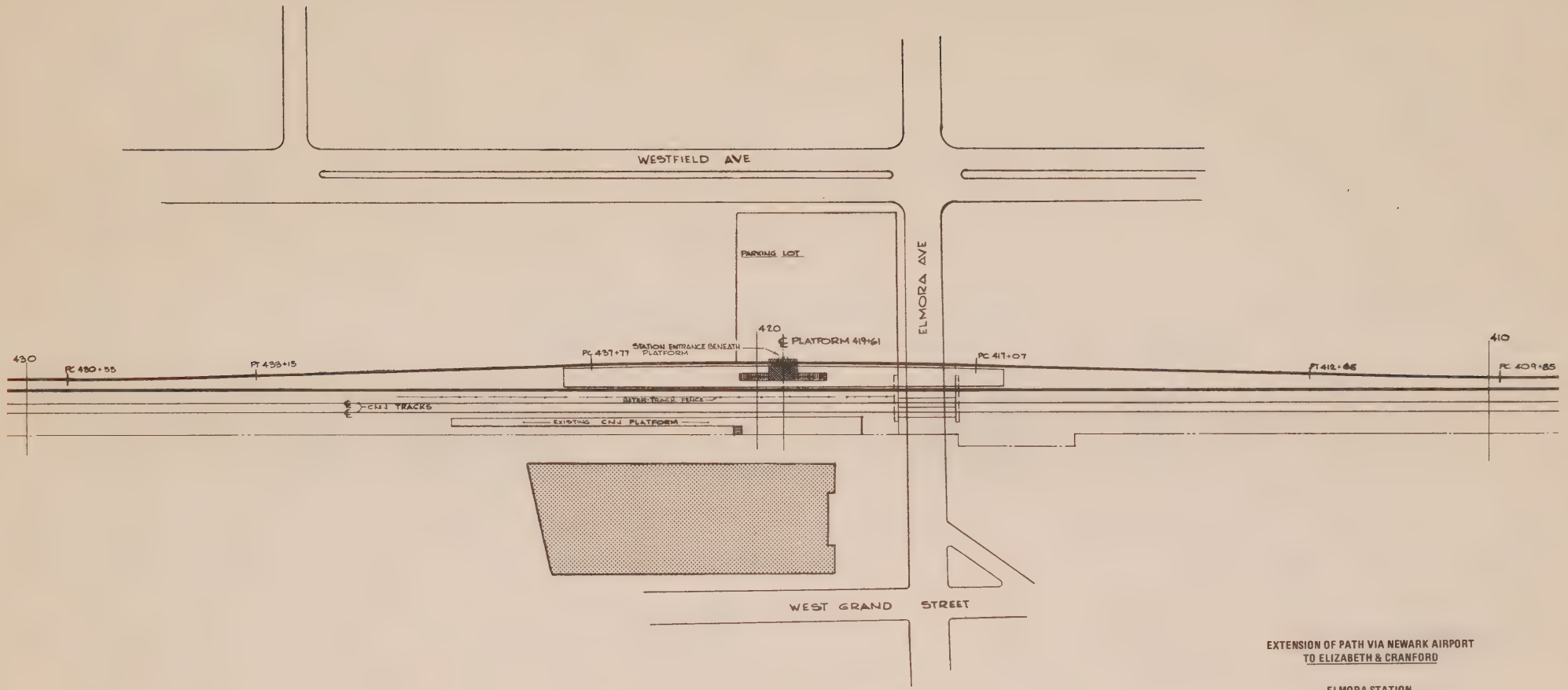
SCALE

EXTENSION OF PATH VIA NEWARK AIRP
TO ELIZABETH & CRANFORD

ELIZABETH STATION

LOUIS T KLAUDER AND ASSOCIATES

PLATE NO. B-48

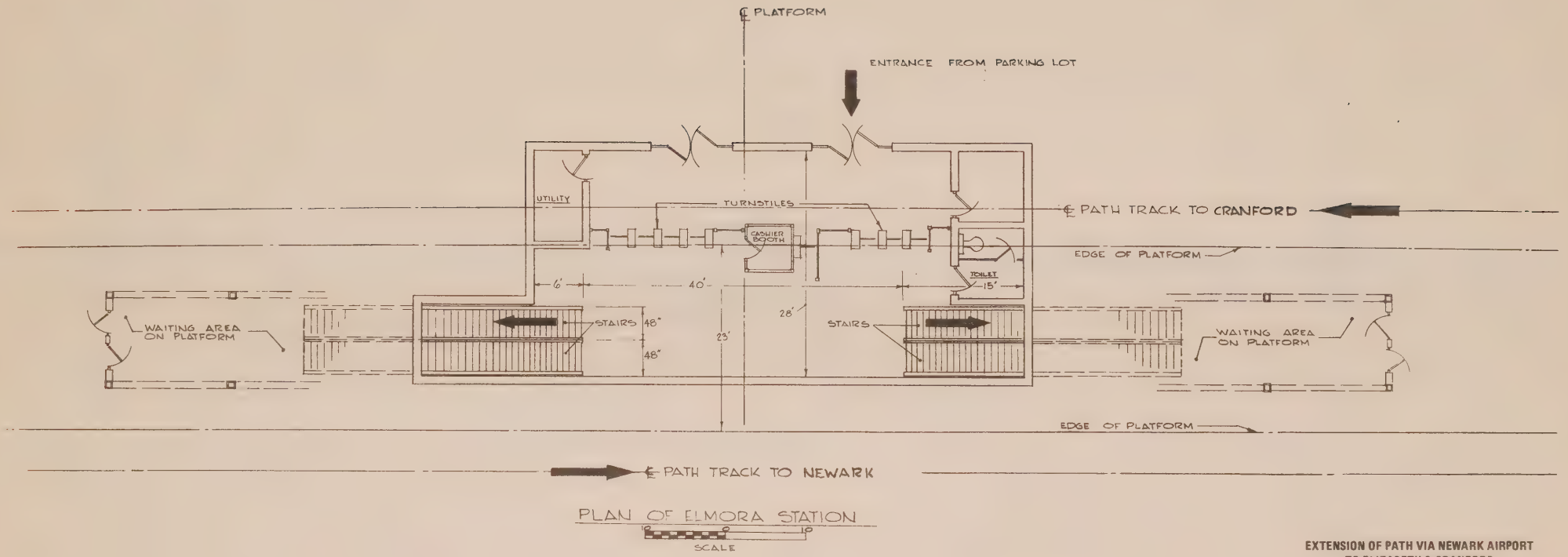


EXTENSION OF PATH VIA NEWARK AIRPORT
TO ELIZABETH & CRANFORD

ELMORA STATION

LOUIS T. KLAUDER AND ASSOCIATES

PLATE NO. B-5A



PLAN OF ELMORA STATION

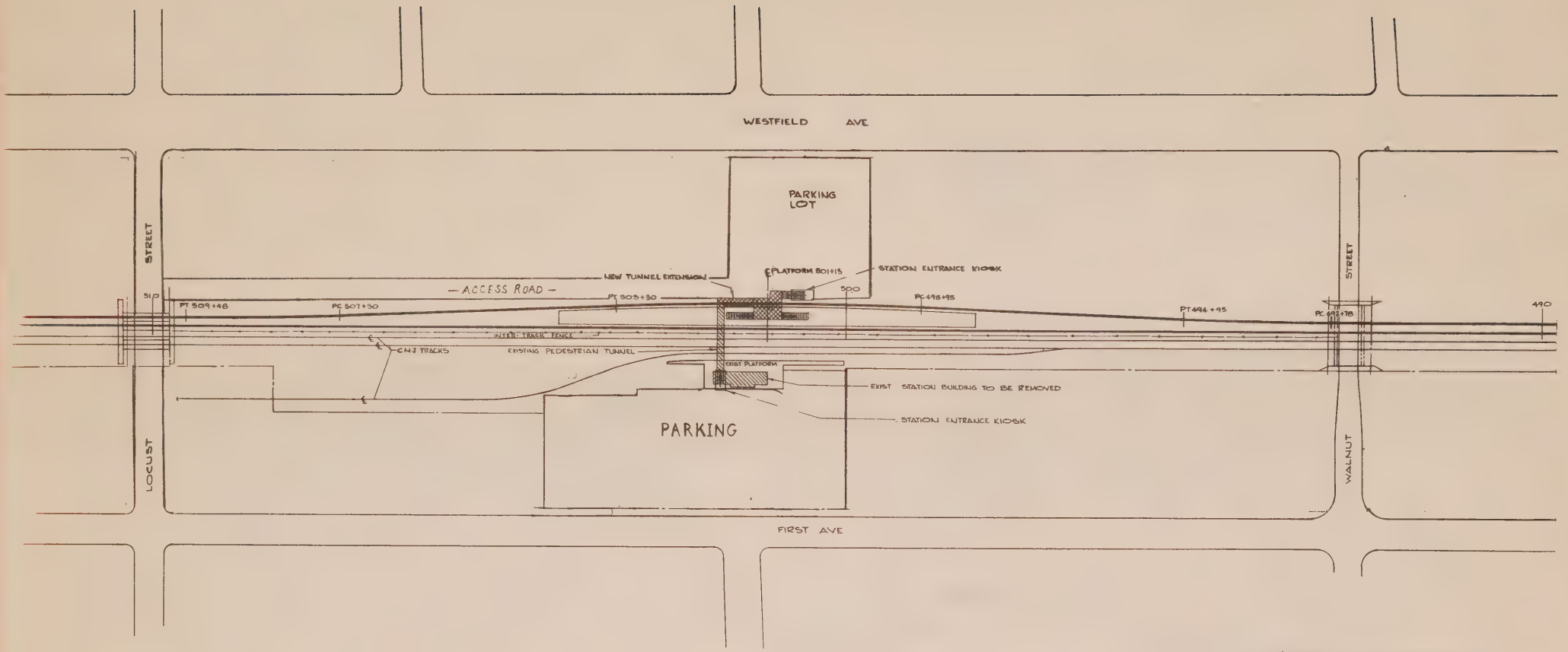
SCALE

EXTENSION OF PATH VIA NEWARK AIRPORT TO ELIZABETH & CRANFORD

ELMORA STATION

LOUIS T. KLAUDER AND ASSOCIATES

PLATE NO. 8-58



PLAN ~ ROSELLE STATION

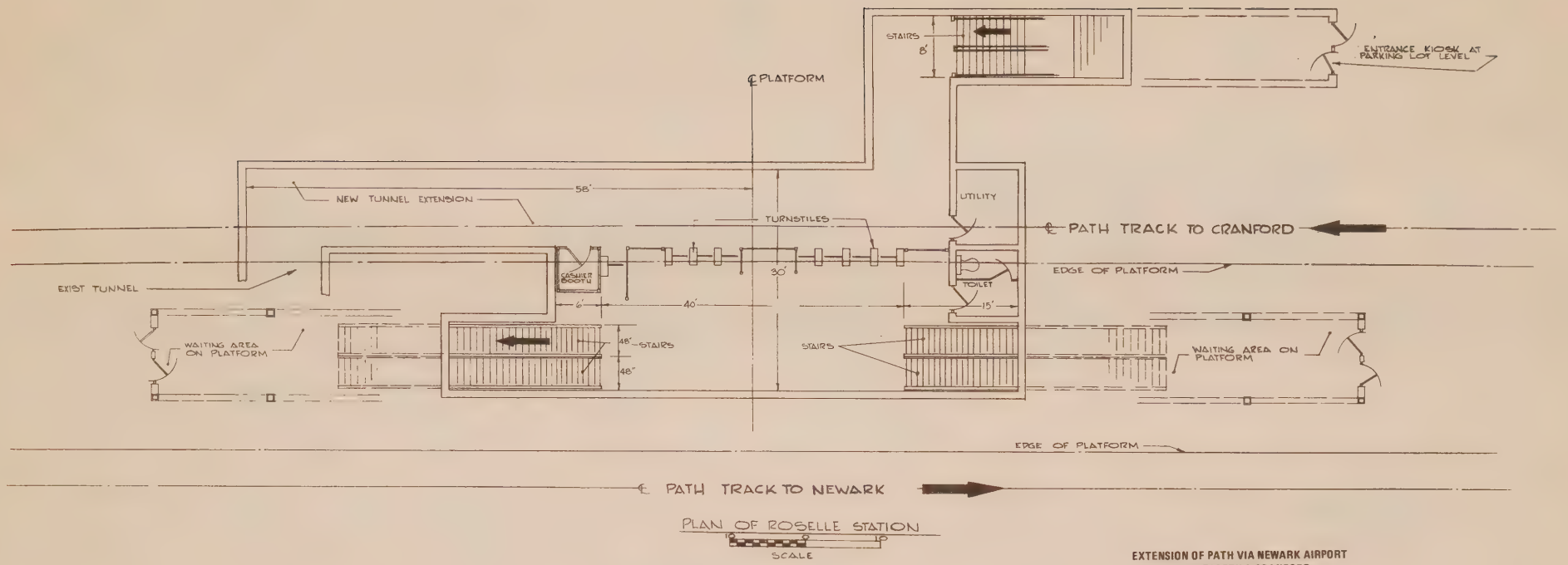
SCALE 100 0 100

EXTENSION OF PATH VIA NEWARK AIRPORT TO ELIZABETH & CRANFORD

ROSELLE STATION

LOUIS T. KLAUDER AND ASSOCIATES

PLATE NO. B-6A



PLAN OF ROSELLE STATION

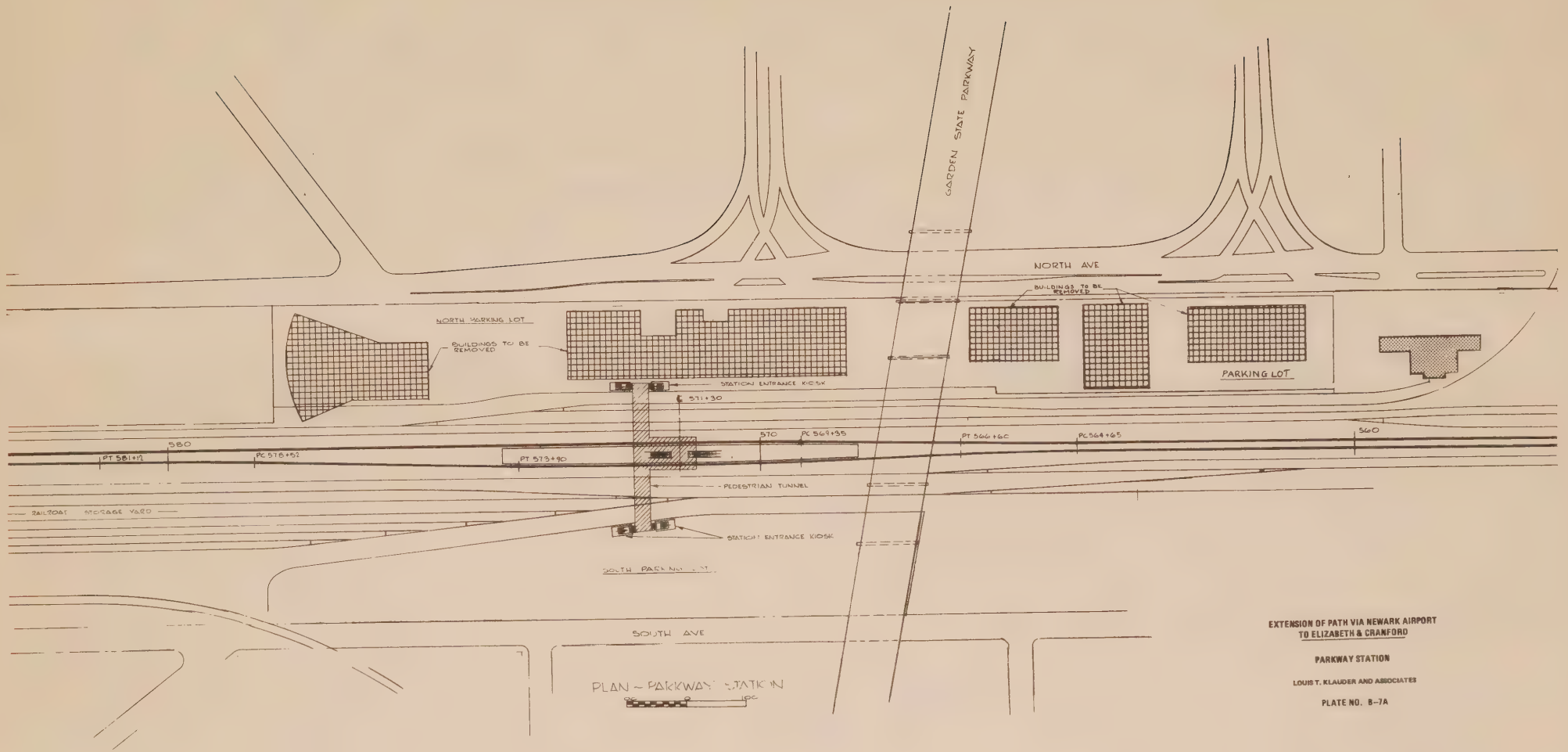
SCALE

EXTENSION OF PATH VIA NEWARK AIRPORT TO ELIZABETH & CRANFORD

ROSELLE STATION

LOUIS T. KLAUDER AND ASSOCIATES

PLATE NO. B-68

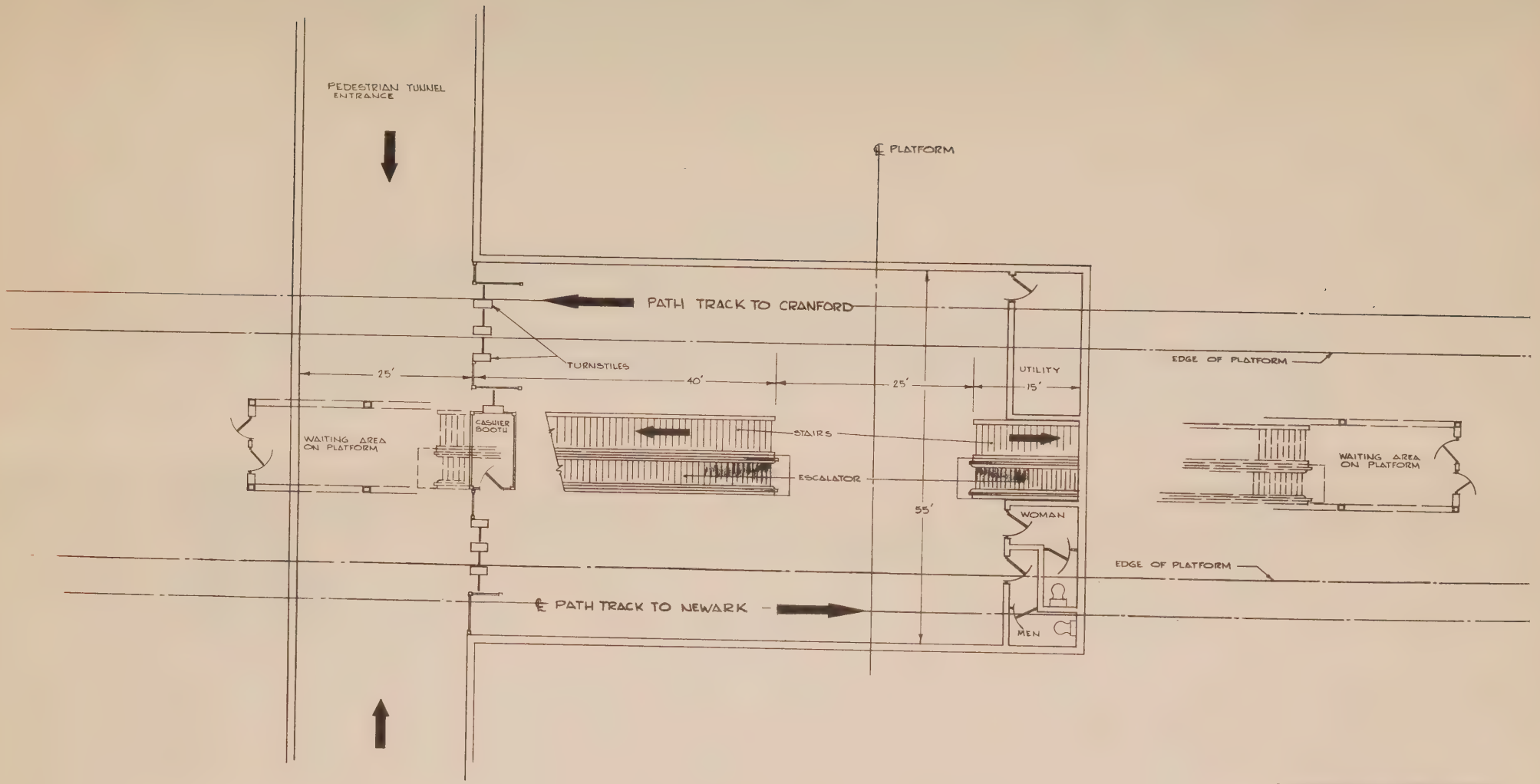


EXTENSION OF PATH VIA NEWARK AIRPORT TO ELIZABETH & CRANFORD

PARKWAY STATION

LOUIS T. KLAUDER AND ASSOCIATES

PLATE NO. B-7A



PLAN ~ PARKWAY STATION

10 0 10

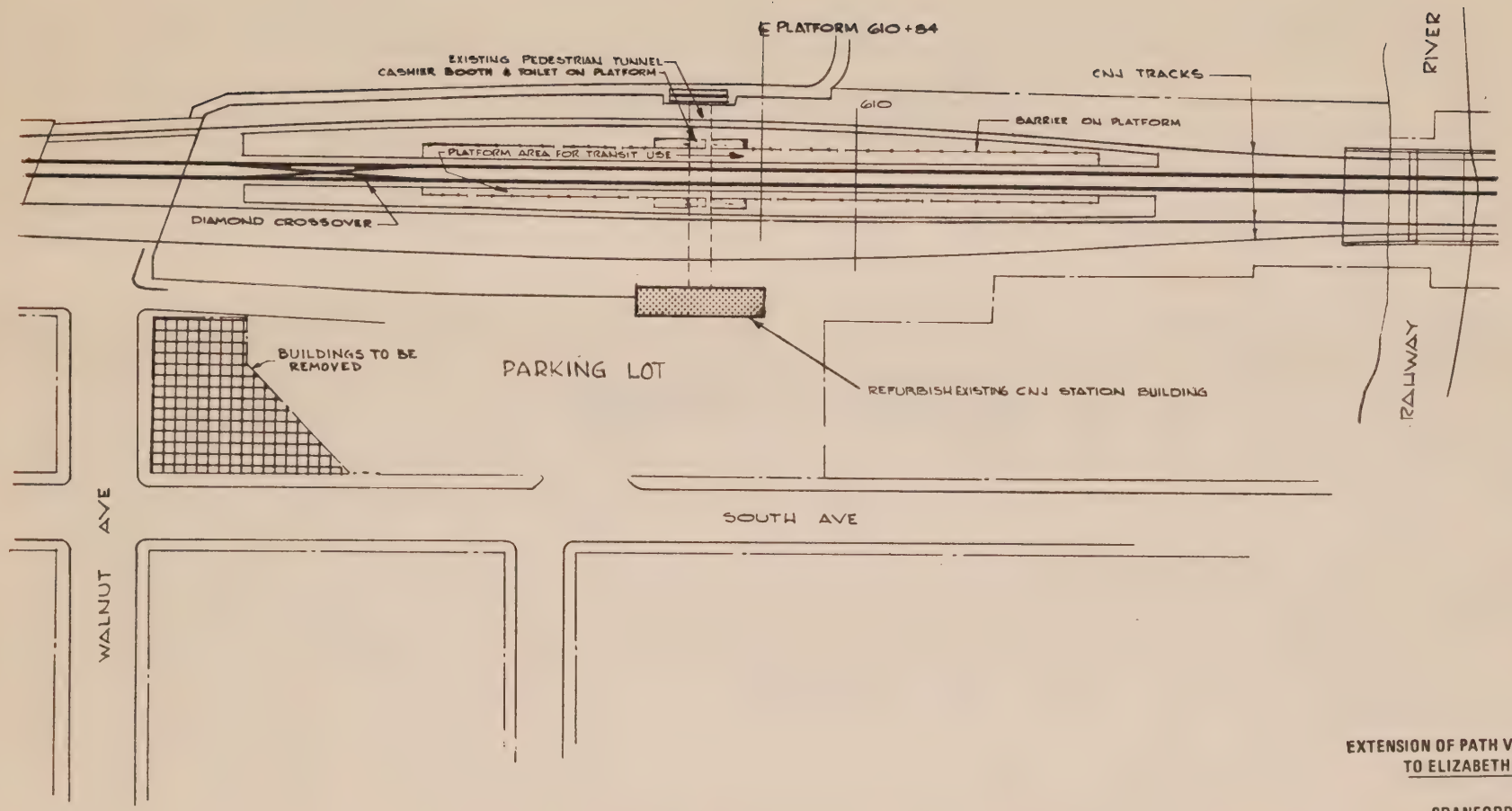
SCALE

EXTENSION OF PATH VIA NEWARK AIRPORT TO ELIZABETH & CRANFORD

PARKWAY STATION

LOUIS T. KLAUDER AND ASSOCIATES

PLATE NO. B-7B



PLAN ~ CRANFORD STATION

100 0 100

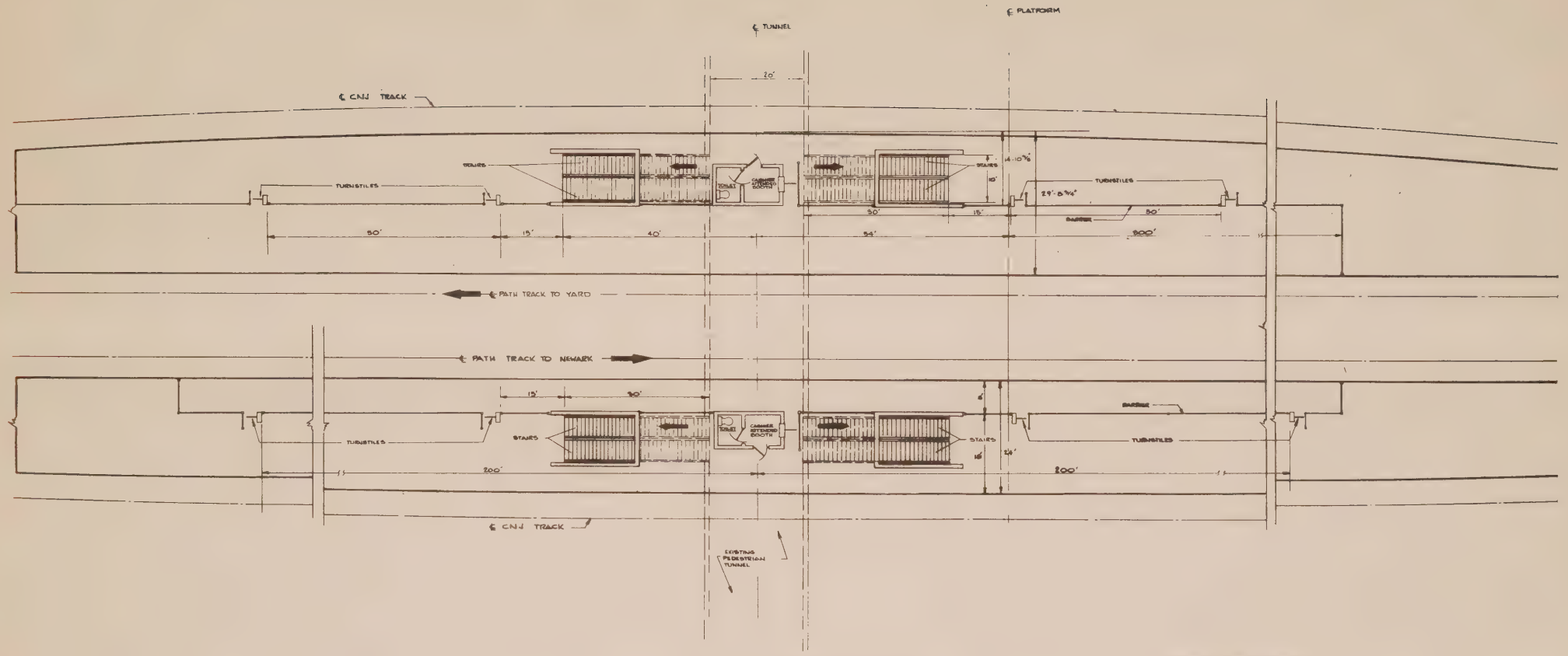
SCALE

EXTENSION OF PATH VIA NEWARK AIRPORT TO ELIZABETH & CRANFORD

CRANFORD STATION

LOUIS T. KLAUDER AND ASSOCIATES

PLATE NO. B-8A



PLAN OF CRANFORD STATION

SCALE

EXTENSION OF PATH VIA NEWARK AIRPORT TO ELIZABETH & CRANFORD

CRANFORD STATION

LOUIS T. KLAUDER AND ASSOCIATES

PLATE NO. 8-88